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WORLD OF VISION

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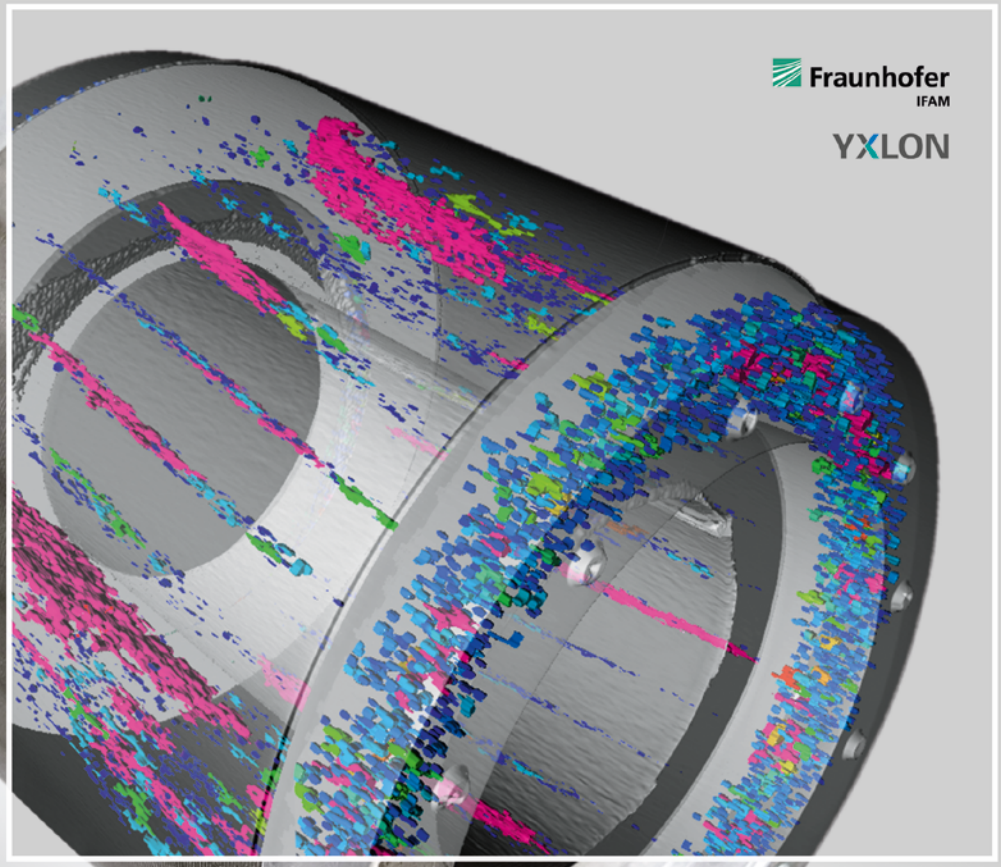


SPECIAL TOPICS

inspect
award 2021

Lighting

## A Look into the Hidden

The First Complete CT of
Cast Rotors for Electric Cars



Partner of VISION AUTOMATICA Control emva VDMA spectronet.

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# Good products deserve an award – **our inspect award.**


**inspect award 2021**

## Vote now and win great prizes!

**Closing date for participation:**
October 16, 2020

Choose the most innovative products in machine vision and optical metrology.

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# Back to School, Back to Work, Back to Revenue

The summer break is over, and we are plunging into the last quarter of 2020. The Corona virus is still there, but we are already testing vaccination. Confidence that we can master this kind of crisis is growing.

According to the EMVA´s latest survey focusing on the effects of Covid-19 on the machine vision industry, the majority of participants expect a U-shaped economic development during and after the crisis and on average anticipate the machine vision industry to contract by 17% in 2020. A confident 80% percent of the companies stated that their enterprise would survive six months or longer until it would ultimately threaten their survival. And two of many statements given about how the virus might impact the industry were: “Any event like this forces change”, and “We look at the crisis as an opportunity”. You will find the details of the survey on page 26.

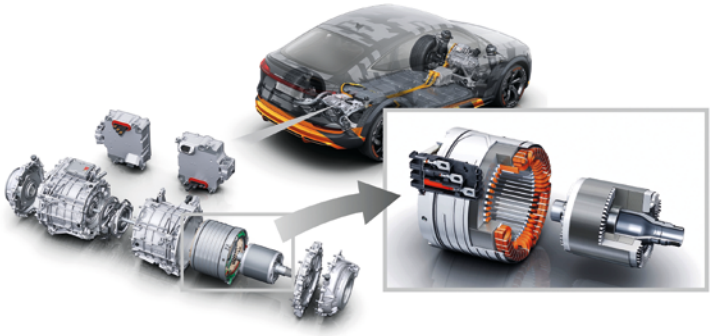
We might still need to slow down a bit longer, but nothing can stop progress entirely, especially not in machine vision. Progress is reflected in our title story from Yxlon and Fraunhofer IFAM that introduces the first complete CT for cast rotors in electric asynchronous motors which can, for example, be found in the AUDI e-tron. For the first time, rotors of the size of electric car traction drives were successfully scanned, providing insights into the internal details of a high-pressure die-cast rotor which were previously not possible.

**The majority of participants expect a U-shaped economic development during and after the crisis«**

Looks like there is light at the end of the tunnel. And who would know better than the vision industry that the right light is important. For example, setting the correct lighting intensity is a critical factor in optimizing images required for inspection and measurement. As CCS´ article on page 14 shows, the integration of lighting and lenses into a unified control environment for application development and operation improves various aspects and paves the way to Industry 4.0.

A lot of signs are pointing towards growth again, a reassuring feeling. Hold on and stay healthy!

Yours,
**Sonja Schleif**



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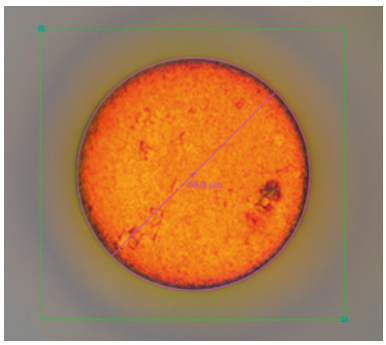
**A Look into the Hidden**



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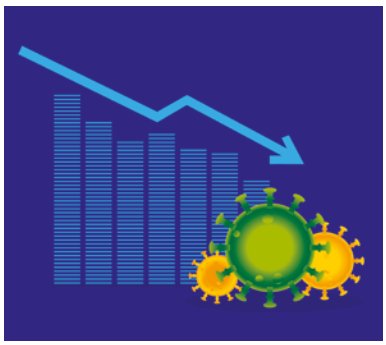

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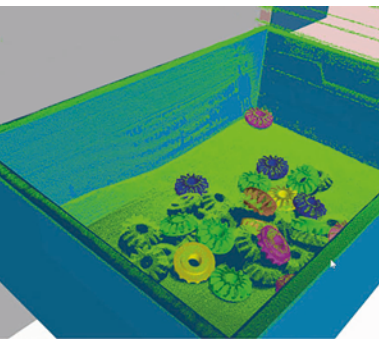



## Control



Partner of: VISION, AUTOMATICA, Control, emva, VDMA, spectronet

Image: Lakesight

**Christian Leitner has been named Head of Sales, Application Engineering and Product Management at Mikrotron.**

## Mikrotron appoints new sales manager

Christian Leitner has been named Head of Sales, Application Engineering and Product Management at Mikrotron, a subsidiary of TKH and manufacturer of machine vision solutions, since August 2020. In his new job he will focus on customer applications as well as design and optimization of customer-oriented marketing strategies.

Previously, Leitner was employed at the sister company LMI Technologies, and before that at Keyence International. He is an industrial engineer and business IT specialist and has been working in the machine vision industry for 12 years.

**www.mikrotron.de**

## Faro acquires ATS AB

Faro announced that the Company has acquired Advanced Technical Solutions in Scandinavia AB, a Swedish-based leader in 3D digital twin solution technology.

Founded in 1990, ATS has had particular success in the automotive space where the firm has agreements in place with several well-known global automotive manufacturers. The acquisition will integrate ATS software and proprietary Traceable 3D system, which enables highly accurate and repeatable 3D scans, into the Faro Webshare Cloud platform. ATS' system connects the physical to the digital world and is expected to bolster Faro's ability to improve customers' time to decision with 10x faster 3D imaging at up to 1 mm accuracy.

**www.faroeurope.com**


Image: Hamamatsu

## Hamamatsu constructs new building for research and development

Hamamatsu Photonics has constructed a new building for its R&D activities and customer service for electron tubes at its Toyooka plant in Iwata City, Japan. It is called "Building No. 5", has about 18,000 square meters and replaces the previous building of the same name, which is very old, the company reports. Hamamatsu has invested around 59 million euros in the new building, which is scheduled to open in September this year.

The new building will concentrate the design and development activities for electron tubes. Currently, they are spread over several buildings at the site. In addition, the total laboratory space is growing. Among other things, this area conducts research on microfocus X-ray sources, which are used for the non-destructive X-ray inspection of electronic components and printed circuit boards, and supercontinuum light sources, which are used for the measurement of semiconductor microstructures. At the same time, the sales and quality control departments will be merged. In addition, the reception area of the new building will be approximately 1.5 times larger than the current building No. 5.

**www.hamamatsu.de**

## Scanlabs parent company invests in Israel

TechInvest Holding, parent company of Scanlab, akquires 25 Percent of shares of HOLO / OR Ltd. The Israeli company is known as a pioneer in the development of diffractive optical elements for industrial applications. By integrating the micro-optic components, or better known as the beam shaper, Scanlab can multiply the use of its scan functions. Diffractive optical elements (DOE) can be used to shape laser beam sight through diffraction effects. With DOEs, the diffractive effect is improved by a microstructure that is etched in a substrate using a lith-controlled method. Glass can serve as a substrate, but plastics, metals or semiconductors can also be used. It is precisely in this market segment that the Israeli company is an experienced player and market leader.

TechInvest Holding, the parent company of Scanlab GmbH, bought a quarter of the shares in HOLO / OR in August 2020. TechInvest wants to acquire the rest of the shares in the coming years.

**www.scanlab.de**

Image: Scanlab


Image: Mesago/Malte Kirchner

**The entrance area of the SPS in 2019**

## SPS 2020 is cancelled

After intensive discussions with exhibitors and trade visitors, the organizer Mesago decided to cancel SPS 2020. This is a response to the wishes of the industry, which does not consider it worthwhile holding the trade fair under the necessary hygiene rules, Mesago continued.

In order to provide the automation industry with a platform for professional exchange this year, SPS Connect will take place from 24 - 26.11.2020 as a virtual event format. The focus will be on the networking of exhibitors and visitors, manufacturers and users and a varied program of lectures on current industry topics. The next SPS is planned for November 23–25, 2021 in Nuremberg.

**www.mesago.com**

# Online Conference of the EMVA Attracts over 130 Participants

## Review of The Virtual Business Conference

**As the planned business conference in Sofia, Bulgaria, was cancelled due to the Corona crisis, EMVA organized the conference virtually for the first time.**

The first virtual interactive EMVA business conference on 26 June was a complete success with over 130 participants, according to the organizers. The online format was necessary instead of the conference in Sofia, Bulgaria, due to travel and distance restrictions imposed by Covid 19. Nevertheless, the participants reacted very positively to the new format.

The structure of the virtual business conference of the EMVA was based on the usual structure of the attendance events. Thus, between the presentations there was the possibility to meet for pre-arranged meetings. The online list of participants made this very easy and convenient. These provided the best possible alternative to personal face-to-face meetings without extending the chain of infection of the Covid virus. The number of meetings held in this way showed that this worked: almost 60 face-to-face meetings took place during the conference. On average, almost every second person accepted this offer. In terms of content, the talks focused on topics such as "New approaches to 3D vision", "Vision-based autonomous navigation", "Artificial intelligence learning at the Edge – Application to integration-free quality control", and "Machine learning and artificial intelligence for automated visual inspection". These presentations were supplemented by the EMVA Outlook 2020/2021 and a summary of the current Vision Standards, each given by Dr. Chris Yates, President of EMVA. The economic outlook that Yates gives for the current and coming year is not surprisingly gloomy: a minus of 10 percent this year and a negative business climate in the industrial and manufacturing sectors relevant to machine vision is the prognosis. But if the lockdowns can be lifted, economic development will recover in the course of 2021, the World Bank estimates.

The conference organizers were pleased that the online conference concept, which was made necessary by the global pandemic, was accepted by the industry. "Not only are we happy to donate the revenue from ticket sales for this event to the WHO Covid-19 Solidarity Response Fund. We are also giving all interested parties access to the presentations in the 'Vision Knowledge' center of our website," says EMVA Managing Director Thomas Lübkemeier.■

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www.emva.org


# inspect award 2021: the Nominees

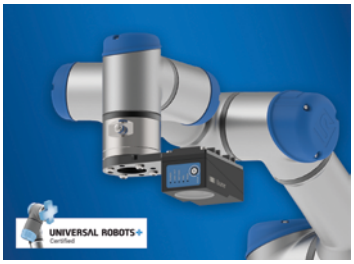
## Vote Now and Win Great Prizes

**The jury of the inspect award 2021 has nominated ten products in the category "Vision" and eleven in "Automation + Control" and the voting is now open until October 16, 2020, so vote on the website www.inspect-award.com and choose the best machine vision product. Three Amazon vouchers worth 50 euros each will be raffled among all participants. Taking part is worthwhile.**

## The Nominees of the Category Vision

### B&R: Vision System – Smart Camera

The B&R vision system is seamlessly integrated into the automation system and forms a complete portfolio of cameras, lenses, lighting and software. The camera is connected to the machine network and automatically receives all necessary settings from the controller. Optimal coordination and integration into the overall system reduces the time required from several days to just a few hours. In addition, products in rapid motion can be recorded at the right time at the exact position with maximum image sharpness. The adaptive adaptability to individual products enables reliable evaluation with high image quality. Each hardware variant can be equipped with one of three image sensors, ranging from 1.3 to 5 megapixels.




### Baumer: Robot-compatible Vision Sensors VeriSens XF900 and XC900

The robot-suitable XF900 and XC900 Verisens sensors enable automatic coordinate alignment with Universal Robots without manual hand-eye calibration. The basis is the Baumer Smartgrid with an intelligent bit pattern applied in a checkerboard pattern. Just a section of the smart grid is sufficient for the vision sensor to determine its position. Since the Cobot knows its position, an automatic coordinate alignment is performed by means of intelligent algorithms and a few movement steps. In addition, Verisens uses the smart grid as a basis for distance-dependent coordinate scaling, image rectification and conversion to world coordinates. This approach makes vision-guided robotics easily accessible to many users.

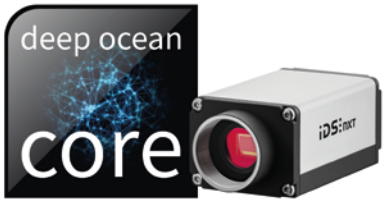
### Cubert: Hyperspectral Camera Ultris 20

The Ultris 20 hyperspectral camera has a native resolution of 400x400 pixels and captures 160,000 pixels at the same time with 100 spectral channels each. The spectral range extends from 450 to 850 nm, the recording itself takes a few milliseconds. No scanning is necessary to obtain a full hyperspectral image. Therefore, neither a rotary bench nor other movable accessories are necessary. Thus, even fast motion sequences can be captured in real-time. This video spectroscopy feature makes it possible to integrate machine vision and other inspection technologies easily and effectively into industrial processes. This allows the supervision and analysis of time-critical processes in real- time.

### Edmund Optics: 1.1 inch Liquid Lens Series

Until now, liquid lenses could not be used in combination with larger sensors: Their small size leads to vignetting. Edmund Optics developed the first complete series of fixed focal length lenses for this application area. Based on Optotune´s liquid lenses, the optics can be focused within a wide range of working distances without any mechanical focus. Embedding the liquid lens within the imaging optics allows for fast F-number designs up to F/2,8 However, the detailed opto-mechanical concept also allows smaller apertures to be used if required. In the first step, focal lengths of 12 mm, 16 mm and 25 mm will be available.

## Category Vision

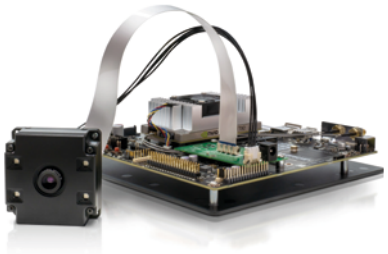



### IDS: All-in-one Inference Camera Solution IDS NXT ocean

With the all-in-one solution IDS NXT ocean, users can create their own inference camera. This enables them to apply knowledge acquired through deep learning to new data. It only takes a few steps to the finished inference camera: Taking sample images, labeling or annotating the images and starting the fully automatic training. The generated neural network can then be executed directly on IDS-NXT industrial cameras, turning them into powerful inference cameras. Already the AI is ready for the specific image processing application. Thus, the AI using an IDS-NXT camera does not require classical programming or predefined rules but only the expertise of the user.

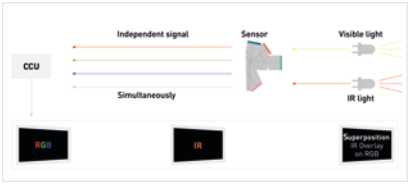

### Isra Vision: 3D Sensor X-Gage 3D

X-Gage 3D is a highly accurate 3D sensor in a compact and robust housing design. It has four high-resolution 5MP cameras and a powerful sample projector. This equipment is complemented by ambient component lighting. The optical design also implements Scheimpflug compensations in order to achieve measuring accuracies in the micrometer range at measuring distances between 140 and 240 mm. The calculation and evaluation of the 3D data is performed on the integrated embedded vision technology. The acquisition including calculation and sending of the data takes less than 1 s. A GigE and power connection connects the sensor to the outside world.



### Lucid: Time-of-Flight MIPI Module Helios Flex

The Helios Flex is a robust, pre-calibrated time-of-flight MIPI module that can be easily integrated into embedded platforms for industrial and robotic applications. The module is equipped with Sony's Depthsense IMX556PLR backlit ToF image sensor and supports the Nvidia Jetson TX2 board. It delivers a depth resolution of 640 x 480, at object distances of 0.3 to 6 m, and uses four 850 nm VCSEL laser diodes at 30 frames per second. A Software Development Kit (SDK) with GPU-accelerated depth processing is supplied free of charge with the Helios Flex. Settings can be adjusted and displayed in real-time.




### Panasonic: OEM Camera 4K 4MOS

Panasonic's 4K 4MOS camera solution helps doctors during surgical procedures by providing high-resolution, detailed 4K-quality images. In combination with other components, it enables tiny but crucial details to be seen, especially during microscopic and endoscopic operations. With the aid of ICG/fluorescent fluid in the patient's body, the 4MOS camera visualizes areas affected by a tumor in oncology, for example. The 4MOS sensor enables the camera to output superimposed real-time images at 60fps in RGB and IR. The images appear in 4K quality – without loss of frame rate. Panasonic holds a patent on this technology.

### Sony: Polarisation camera with SDK

The IMX250MZR is the first sensor to integrate pixel-level polarization functions. It can filter light in four planes (0, 90, 45, 135°), assigning pixels to one plane of a 2x2 calculation unit. Sony ISS has now coupled this sensor with the first (and currently the only) Software Development Kit (SDK) to simplify designs based on this camera and reduce development time from 6 to 24 months to 6 to 12 weeks. The SDK includes highly optimized algorithms, a dedicated image processing library, and a growing number of reference applications created with partners to accelerate designs. The SDK is created for use with Windows PCs and Sony will soon announce a second SDK for the Nvidia Jetson computer.


### Ximea: MX377 – Scientific Camera

The MX377 is designed for a wide range of scientific applications, e.g. high energy physics, TEM, astronomy, SSA. The camera delivers 37.7 Mpix at a pixel size of 10 µm. It has a high dynamic range and low noise and can be cooled with air or water. The MX377 is supported by Windows, Linux, MacOS and follows the standards of PCI Express and Genicam. The sensor format is 61x61 mm with a resolution of 6k x 6k and two power amplifiers. The MX377 achieves a maximum quantum efficiency of 95 % with a dynamic range of up to 90 dB, at a full-well capacity of 110 Ke-.

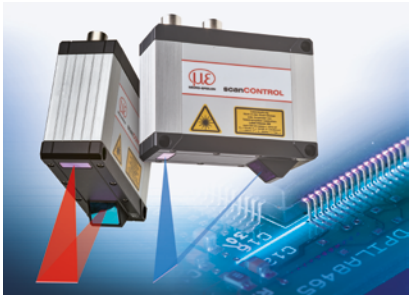
# The Nominees of the Category Automation + Control


## 3D Infotech: Vision-Software Streamline

Streamline is the only available automation software solution that provides a universal solution that supports any 2D vision or 3D scanner, and any combination of industrial or collaborative robotics. Streamline gives end users complete control over their process and democratizes the implementation of 3D robotic measurements (automated quality control). Streamline as a digital industry 4.0 hub is compatible with devices such as: 3D scanners of any type/brand, 2D vision cameras, 1D sensors of any type/brand, optical or laser position trackers, and industrial and collaborative robots.

## Keyence: Optical Coordinate Measurement Machine LM

The Optical Coordinate Measuring System LM is a high-precision measuring device for the inspection of components. It takes care of illumination and focus settings and even searches for the component in the measuring range. Due to its high resolution and intelligent user interface, measurements in the micrometer range can be performed intuitively and automatically. Small geometries, which could otherwise only be seen under a microscope, are measured at the touch of a button. The LM can also perform precise optical height measurements. In addition, users can measure several identical objects simultaneously. The devices can be used close to production.

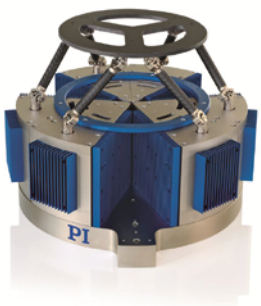


## Micro-Epsilon: Laser Scanners Scancontrol 30xx

The laser scanners of the Scancontrol 30xx series offer high performance and are used for fast and precise 2D/3D measuring tasks with up to 10,000 Hz. The integrated controller calculates and evaluates the profiles. The Scancontrol Gateway enables the results to be transferred via interfaces such as Ethernet, Profinet, Ethernet/IP or Ethercat. The compact and lightweight profile sensors are equipped with the real-time surface compensation for dynamic adaptation to changing surfaces and the high dynamic range mode for measurements on inhomogeneous surfaces. Furthermore, there are different operating modes for individual requirements.

## Photoneo: Automated depalletization solution Depalletizer

Photoneo Depalletizer is an intelligent automation solution for unloading pallets loaded with boxes using AI. This is achieved by combining internally developed 3D image processing with a large scan volume – Photoneo Phoxi 3D scanner – and machine learning algorithms that have been trained and tested for more than 5,000 types of boxes. So it works out of the box, without necessitating any training of the system. The specially developed universal gripper performs the gripping process with an accuracy of ±3 mm. It can thus unload 1,000 boxes/hour with an accuracy of 99.7 %. Photoneo Depalletizer reduces throughput, increases productivity and safety and saves costs.




## Physik Instrumente: Hexapod H-860

The Hexapod H-860 is the only multi-axis system that achieves the required angular movements with the appropriate frequencies and repeatability to reliably test cameras, ensuring high image and video quality and supporting camera-based innovations. The combination of highly dynamic linear motors and the lightweight design with highly rigid carbon milled parts enables fast and precise movements as well as high accelerations. The parallel kinematics with a freely selectable coordinate reference system can be used flexibly, thus enabling more complex prototype tests.

## Category Automation + Control

### Polytec: Surface measuring device Topmap

The optical measuring instruments Topmap Micro.View and Micro.View+ characterize the surface quality of precision-machined parts in a non-contact manner and with high lateral and vertical resolution. These optical profilometers determine highly accurate parameters such as texture and roughness, but also flatness on fine and sensitive structures. The "Continuous Scanning Technology" extends the vertical measuring range up to 100 mm (compared to 250 µm measuring range of the predecessor model). In addition, both devices feature the robust "ECT Environmental Compensation Technology" measuring method, which is insensitive to disturbances in production environments.

### Trioptics: Measurement device for camera lenses Optispheric HR

The Optispheric HR is a further development of the classic Optispheric. It was developed for high-precision measurement of the focal length (FFL) of short focal length lenses with an effective focal length (EFL) of 0.3 mm to 12 mm. The measuring accuracy of ±4 µm and the repeatability of 2 µm for the FFL is achieved by the automated and precise positioning of the measuring head. Due to the inverted design, the object-side collimator is located above, the image-side detector below the test object. This ensures the reproducible positioning of the test specimen directly on the reference surface for the system dimension determination – the test specimen holder.

### Visiconsult: Inline CT Solution

Many manufacturers prefer a 100 % inspection, i.e. a quality control of every single part produced as well as the inside and outside, for example in the production of components for electric vehicles. The idea of an inline CT solution was born and Visiconsult developed and produced several of these solutions worldwide. Integrated into an inline production and with a cycle time of 42 seconds, this inspection no longer causes any loss of time. Due to the CT scans it is possible to perform 3D analyses, which means that it can be inspected 100 % non-destructively. In addition, the automatic evaluation (ADR) eliminates the need for personnel.

### Werth Messtechnik: Computed Tomograph TomoScope XS FOV

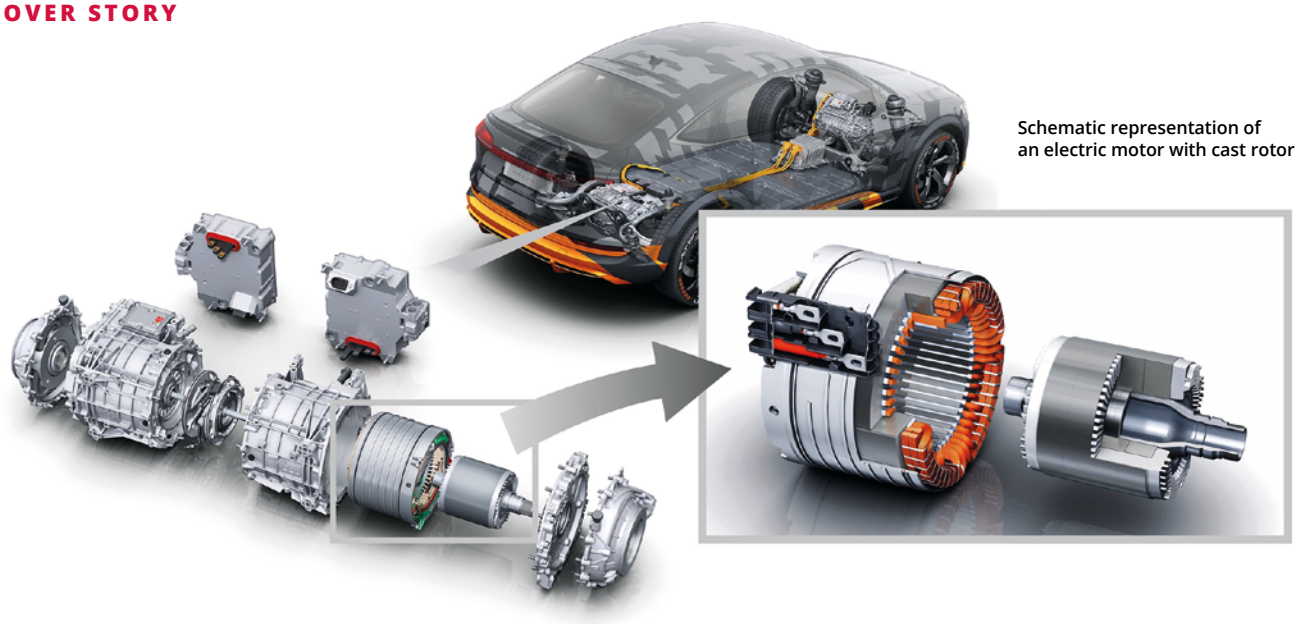
With the third model in the Tomoscope XS family, Werth Messtechnik now offers X-ray tomography at the price of conventional 3D coordinate measuring machines. Measurement with the Tomoscope XS FOV is fully automated. The operator simply positions the workpieces on the rotary table and starts the measurement. With an in-image measuring range of about 120 mm, the 6-megapixel detector and on-the-fly operation, the tomoscope XS FOV is suitable for the measurement of plastic parts. The device is practically maintenance-free and thus offers high availability. Due to the short measuring times it is also suitable for inline and atline applications.


### Westcam: Crack Detection System BVS-R

The BVS-R is a camera-based crack detection system from Westcam for the detection and tracking of cracks during fatigue tests on endurance test benches. The main features include continuous, percentage accurate progress monitoring without personnel, continuous monitoring of test benches including crack image data recording or triggered image recording via test bench signal. In addition, an automatic test bench shutdown when a defined crack length is reached or the automatic measurement of the crack length can be set. The system allows the use of six cameras simultaneously for each test series or six test benches in parallel operation.

### Yxlon: X-ray and CT system UX20

Yxlon UX20 is a modular, compact X-ray system that can be adapted to the user's needs through options and upgrades. Unique is the simple and ergonomic operation. The Geminy interface, which combines all the programs involved, with graphic elements, presets and wizards, enables intuitive operation using joysticks and buttons. The menu-guided creation of automatic inspection sequences is as easy as a manual X-ray and CT inspection. The large inspection area allows parts of up to 80 x 110 cm. Generator, cooler and HV-cable are safely integrated in the cabinet.



Schematic representation of an electric motor with cast rotor

Image: Audi

# A Look into the Hidden

## The First Complete CT for Cast Rotors in Electric Asynchronous Motors

**Electromobility confronts the automotive industry with many new challenges. New components sometimes require new test methods to ensure functionality and safety. Research and development are running at full blast and partnerships find solutions that clearly push the current boundaries of what is possible. In a joint project, the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM and Yxlon International have succeeded for the first time in taking a look into the inside of cast rotors.**

The knowledge that cast rotors for electric asynchronous motors often suffer from casting defects like cavities and porosity is as old as the technology for casting rotors itself. In a so-called asynchronous machine, such as the one used in the Audi e-tron, the rotor is powered by the electromagnetic field of the coils and transmits the power generated in the electric motor via the shaft to the wheels.

Assured material- and product quality is important for the electric car's maximum performance and thus, the driving pleasure. In the field of industrial drives, knowledge of casting defects in rotors was accepted for decades and minor losses in performance could be neglected. But since the rapid growth in electromobility, the automotive sector has been placing significantly higher demands on quality and ensured performance.

### Defect Detection in Rotor Conductor Bars is Critical

So far, non-destructive quality testing of rotors has been limited to two methods: the experimental test stand and radioscopy. Although electrical performance testing on special test stands provides information about the effective performance, it does not provide any direct conclusions to be drawn about casting quality and casting defects. The relevant imaging inspection method of computed tomography (CT) however was limited to the externally exposed short-circuit rings made of cast aluminum, whose material density of 2.7 g/cm³ is comparatively low compared to the thick-walled steel sheet package (density ~ 7.6 g/cm³). However, these short-circuit rings are of secondary interest from an electrical point of view. Much more important and more critical is the detection of casting defects in the rotor conductor bars made of cast aluminum. These are "hidden" inside the lamination stack and electrically connect the two outer short-circuit rings with each other. Casting defects in these areas would lead to a reduction of the effective conductor cross-section or even interrupted rotor conductor bars due to cold runs or enclosed flow front oxide layers. Consequently, the electrical performance of the entire motor, including thermal problems, suffers directly. This means that casting defects and inhomogeneities in these areas lead to performance losses as well as one-sided magnetic pull and thus can take effect to an uneven rotation of the rotor, which can result in increased bearing loads and damage to the electrical machine, especially at high speeds.

### New Insights in Internal Rotor Details

A complete CT scan of a rotor is therefore desirable but was previously not feasible due to the unfavorable material pairing of a high-density steel-based lamination stack and low-density cast aluminum rotor conductor bars. The Fraunhofer Institute for Man-

### Manufacturing Process of Cast Rotors for Asynchronous Motors

Cast rotors are preferably manufactured by aluminum high-pressure die-casting. A cylindrical laminated steel sheet package with axially continuous recesses (the electrical conductor slots) is stacked from single, usually 0.3–0.8 mm thick punched electrical sheets. This stack is placed into the casting mold and during the casting process, a short-circuit ring is firstly cast onto the front side of the lamination stack. Almost simultaneously, all the conductor slots get flowed and filled with melt coming from this front ring. Finally, the second short-circuit ring on the opposite side is filled with the melt running out of the conductor slots.

Due to their high wall thickness, these short-circuit rings tend to a lot of cavities caused by solidification – especially the short-circuit ring opposite the sprue, which can hardly become re-densified via the gating system. Due to the high thermal losses when flowing through the comparatively thin conductor slots, the molten aluminum quickly loses temperature and pre-solidifications can affect in the conductor slot area within the lamination stack. Moreover, casting with ultrapure "rotor aluminum" in the 99.5–99.7 quality prevents a generous solidification interval, which can usually be used for re-densification and the avoidance of cavities caused by solidification.

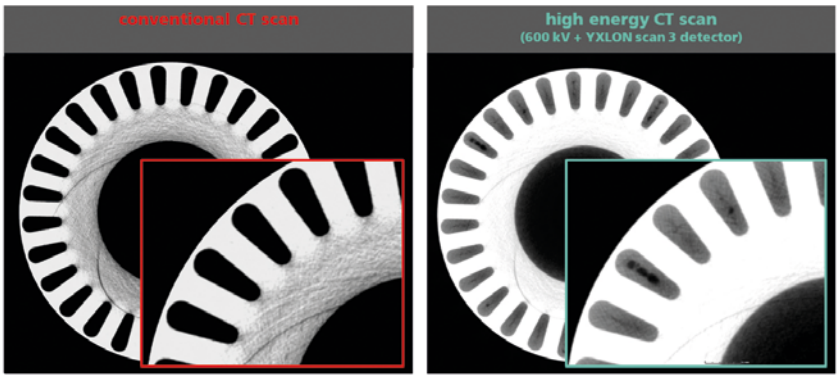



Image: Yxlon

**Conventional CT scan of a cast rotor with insufficient resolution of the rotor conductor bars (left) and CT scan with Yxlon FF85 CT system, 600 kV and CTScan 3, showing axially continuous cavities in the rotor conductor bars (right)**

Image: Yxlon

**High-resolution line detector array Yxlon CTScan 3**

ufacturing Technology and Advanced Materials IFAM has been engaged in the casting processes and quality improvement of rotors for many years. In cooperation with Yxlon Inspection Services, for the first time, rotors of the size of electric car traction drives were successfully scanned in the new Yxlon FF85 CT computed tomography system at 600 kV and the high-resolution Yxlon CTScan 3 line detector, providing insights into the internal details of a high-pressure die-cast rotor which were previously not possible.

The line detector CTScan 3 developed and manufactured by Yxlon International was introduced in 2018 and used for the first time in the computed tomography system CT Compact. Thanks to machine-supported cutting of the crystals, their uniformity has been improved by a factor of 5. This leads to reduced ring artifacts, and the high repeatability of the signal allows optimal calibration. Due to the higher dynamic range and better signal stability, greater material thicknesses can be tested with the same x-ray energy. The solid housing is particularly resistant to temperature fluctuations, ensuring optimized cooling of the electronics. At the same time, this material combination leads to very little scatter within the detector, resulting in sharper images, cleaner edges and an improved detail detectability.

This new success in imaging quality inspection with the high-resolution Yxlon CTScan 3 opens up new paths in the development and series production of cast rotors, and also first scans at 450 kV brought excellent results. Until now, the design of casting tools has been limited to classical simulations of mold filling and solidification. In the future, samples cast in the early prototype phase can already provide information on whether casting concepts are leading to the desired goal and whether changed process parameters influence the reduction of casting defects. Likewise, trapped gas porosity can be detected, which has arisen due to burn-off or thermal outgassing of the electrical sheet insulation coating during casting. Accompanying the series production, it is possible to control the quality by random sampling and to detect changes due to tool wear or changes in the delivered quality of the electrical lamination sheets at an early stage.

## Defect specification as basis for performance calculation

The three-dimensional display of casting defects now allows the next step for rotor inspection. The Fraunhofer IFAM is working on the computer-based prediction of the real performance of rotors in consideration of casting defects. For this purpose, the previously scanned porosity model of the rotor is imported into special software which examines the effects of the reduced electrical conductor cross-sections in the rotor conductor bars due to cavities, entrapped air or other casting defects in a simulation model. The calculated reduced performance values are compared with those of an ideal rotor. This way, the determination of a "scrap factor" should be possible specifying the degree of casting defects possible for the rotor to still provide the required performance values.

Differences in defect distribution ("homogeneous fine distribution" vs. "locally inhomogeneous accumulation") do not only affect the electrical performance, torque, and heat dissipation. The so-called magnetic eccentricity is a result of unequally distributed porosity in the rotor, too. From a mechanical point of view, these resulting imbalances are currently eliminated in a simple way by individually measuring and balancing the rotors analogous to "wheel balancing". From an electrical point of view, however, the problem has not yet been solved because inhomogeneous rotor conductor bars lead to a one-sided "magnetic pull" and the rotor rotates unevenly during operation. Waviness in torque, uneven and acoustically noticeable running, especially at high speeds, and increased bearing load on the rotor shaft are the result. ■

### Yxlon Inspection Services

Yxlon Inspection Services offers application- and inspection services using non-destructive x-ray technology at eight locations worldwide. The Hattingen site is equipped with almost all Yxlon x-ray and CT system types and an additional linear accelerator for high-energy applications up to 9 MeV. New solutions for unusual inspection tasks such as the cast rotors are being worked out in close cooperation with the R&D team at the headquarters in Hamburg.

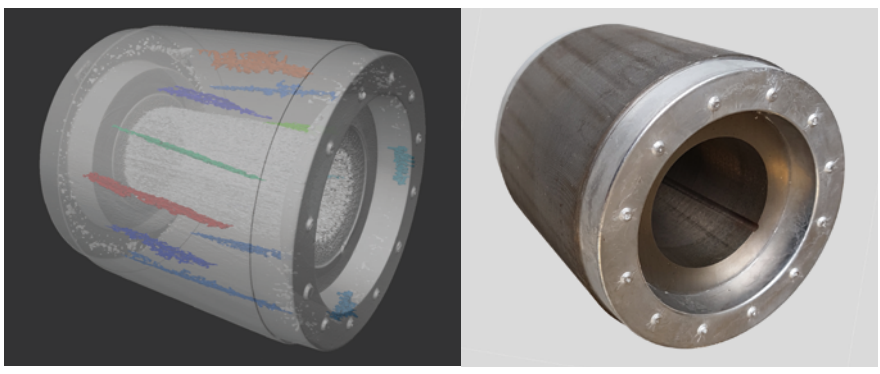


Image: Yxlon

**Three-dimensional representation of the casting defects and defect distribution from the high-resolution CT (left) and photo of the cast rotor which externally appears free from defects (right)**

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# Intelligence Inside

## Integrating Intelligent Lighting into Machine Vision Systems

Image: maru54 - stock.adobe.com

**The integration of lighting and lenses into a unified control environment for application development and operation improves various aspects and paves the way to Industry 4.0.**

While individual components in a machine vision system have their own functionality, the end result is achieved as a result of the way they work together. Optimizing the setup of individual components to achieve the best imaging solution for a particular application can be both time-consuming and challenging. There are therefore compelling arguments for integrating components such as lighting and lenses into a unified control environment for application development and operation. 'Plug & play' intelligent lighting improves the speed and ease of development of vision solutions, provides advanced lighting control functionality and makes lighting data and information available throughout the system. This also provides the foundations needed for implementation within Industry 4.0, especially in the context of diagnostics and predictive maintenance.

### One Environment for Developing Machine Vision Solutions

Setting the correct lighting intensity is a critical factor in optimizing the image required for a particular inspection or measurement using a machine vision system, together with choosing parameters such the camera gain and exposure time. If the light needs to be strobed and/or overdriven, these parameters will also need to be set. However, if the lighting and camera can be connected and integrated with adjustment through a single interface, it is possible to see immediately the impact that the adjustment of each component is having on the resultant image in terms of signal to noise ratio, contrast etc. This not only simplifies set up and development but ensures that advanced lighting parameters for accurate strobing and overdriving can be set to synchronize seamlessly with camera triggering and exposure times. This can be particularly important where the use of multiple lights and cameras might require the set-up of complex sequencing configurations. The inclusion of intelligence in the lighting system then brings additional layers of lighting control which can include monitoring, sensing and feedback of lighting intensity to automate lighting performance and further improve illumination consistency.

### Facilitating Lighting Set-Up and Control

Delivering sufficient light consistently and reproducibly to an imaging scene is essential to ensure accurate and reliable machine vision measurements. Precise lighting control is critical since a number of factors can affect LED output. These include the maximum rating of the light, the amount of current used to drive it, the temperature of the light (since LED output decreases with temperature) and the number of hours that the light has run (since LED output decreases slowly over time). In addition, for many applications, lights are operated in pulsed mode rather than continuous operation, either to freeze motion, or deliver increased light output or both. By driving the LED with more than its standard current rating (overdriving) in short pulses, more than 100 % continuous brightness can be delivered when extra light intensity is needed. Within intelligent lighting, pulse frequency, triggering, duration and intensity can be easily and automatically monitored and controlled to prevent damage to the light. This usage information is also important for operational or diagnostic purposes as well as a reference for pre-emptive maintenance of the system. This easy control also allows the implementation of more advanced functions including complex sequencing which otherwise might have been considered to need specialist setup. A dedicated lighting controller can be configured to drive the LED in the required manner, but connectivity is critical to achieving an integrated system. Ethernet connectivity lies at the heart of single environment integration for lighting systems in industrial machine vision applications, from PLC-driven automation systems through to GenICam compatible open protocol PC-controlled systems.

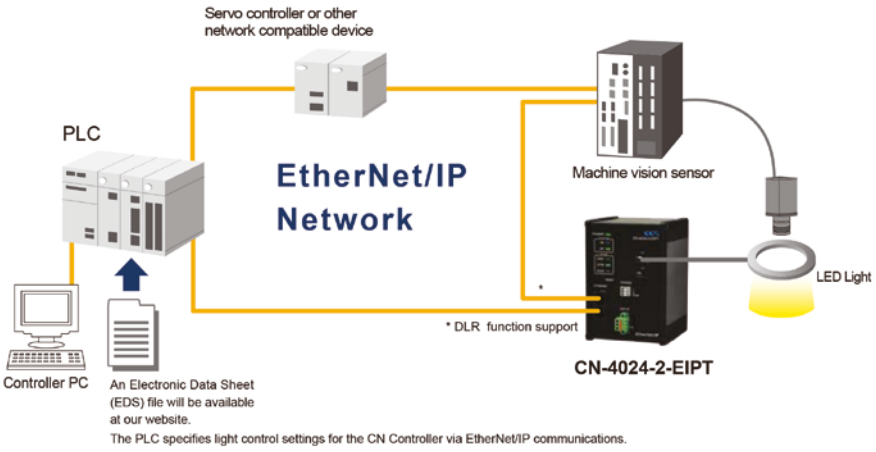


Image: CCS Europe

**Lighting control in a PLC environment**

### Unified Automation and Machine Vision Control Environments

In many industries, particularly automotive and food, automation systems utilize PLCs on industrial networks such as Ethernet/IP. Smart lighting controllers for these types of network provide easy connectivity for lighting setup, control and maintenance. A PLC program editor can be used to set up the lighting control functions such as strobing,

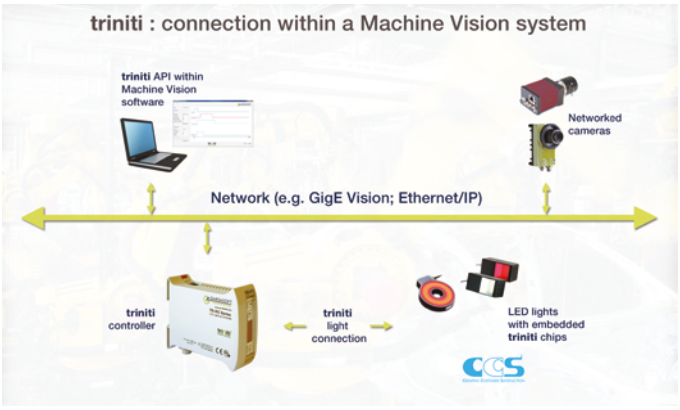


Image: CCS Europe

**Open protocol integration of lighting control, cameras and image processing**

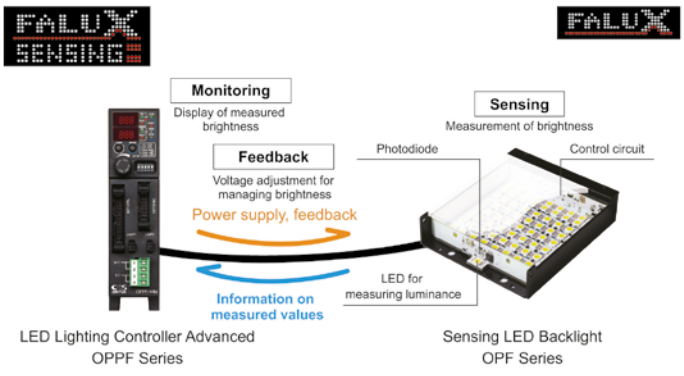


Image: CCS Europe

**Fully automated feedback control of light intensity**

overdriving, pulsing or continuous operation. The values for accumulated trigger count, accumulated lighting duration based on light intensity and strobe time, lighting delay and error status can all be made available through the Ethernet/IP network. For PC-controlled machine vision systems, the ideal configuration is an integrated system where control for both camera and lighting parameters is provided through a single software interface in a 'plug-&-play' environment. This makes systems much easier to create, configure and commission. Both open and closed environments are available, and importantly both allow the selection of lights in a variety of form factors, including ring lights, square lights, bar lights, flat lights, dome lights and co-axial lights to allow for an enormous range of applications. Open environments, such as triniti lighting systems from CCS utilize standard machine vision networking and communication architectures such as GigE Vision and GenICam. This approach allows the use of any GigE Vision camera, together with a lighting controller and intelligent lights from a number of different manufacturers which can store lighting data within the light itself. The control system can automatically access an individual LED's information such as the maximum strobe and overdrive capabilities to help with system configuration. Access to dynamic operational data such as on-time, and hours of operation allows remote diagnostics and data-logging. APIs are available for a number of imaging and application processing software packages to provide a single control interface within the user's preferred image processing environment. Within the Compact Vision System (CVS) space, systems are more typically vendor-specific and their integration of machine vision components commonly utilizes dedicated closed protocols. Nevertheless, a similar lighting integration approach can be applied in these more closed environments, except the set-up and control of the lighting is performed using vendor-specific camera software. Closed configurations may include an integrated lighting controller in the system that can be used with external LED lights, or use specially developed LEDs, which have their own integrated controller.

## Extending the Reach of Intelligent Lighting

LED lights used in machine vision are typically assemblies containing a number of individual LEDs. As discussed before, a number of factors affect the intensity output of an LED, including temperature, the length of time that it has run, and any variations in the input voltage. Some specialist applications, particularly in the glass, semiconductor, pharmaceutical and microscopy sectors require very accurate control of lighting intensity over time. To meet these needs intelligent lighting technology has been developed featuring lighting control and illumination feedback functionality. These lights are available in a variety of form factors and feature multiple built-in photodiodes, to allow accurate measurement of individual LED brightness both for continuous operation and in pulsed mode, as well as a temperature sensor. Using constant current circuitry dependent on the input voltage, any variations in the forward current of individual LEDs are corrected to give uniform brightness. In addition, a temperature compensation circuit corrects for fluctuations in brightness due to changes in operational or ambient temperature. Since all operational information is seamlessly available via GenICam these intelligent lighting systems can also be integrated with cameras, imaging software and diagnostic systems for control in a single environment.

## Preparing for Industry 4.0

Intelligent lighting solutions are available across a variety of platforms, enabling machine vision systems to be more easily set up and configured both now and in the future. However, with lighting information and data for diagnostics and predictive maintenance readily available over these networks the foundations are also in place for future integration into Industry 4.0-enabled environments, where data exchange between components and subsystems is an essential requirement. One approach to the correlation of automation and machine vision intelligence is the OPC UA platform-independent open standard for machine-to-machine communications. Under the direction of the VDMA Machine Vision Group work has been ongoing on the OPC UA Vision standard which describes the interface between automation and machine vision in a uniform form. Part 1 of this standard has been completed and work has begun on Part 2, which will include investigation of the possible interaction of GenICam and OPC UA Vision adding even greater importance to GenICam compatibility for intelligent lighting systems. ■

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Midopt acrylic protective windows are made with highly transparent acrylic and come standard with multi-layer anti-reflective and oleophobic coatings.

**Using the best protective window and coating combination for a given machine vision application can lead to better equipment performance, increased protection and efficiency, and reduced overall cost.**

# Protection Boosts Performance

## How Protective Windows and Coatings Influence Performance of Machine Vision Systems

For over 30 years, Midwest Optical Systems has been developing expertise in optical design, fabrication and inspection. The company offers a variety of options for protective windows, which are tailored to a wide range of applications and budgets. The base material used for each type of protective window dictates its suitability for a given spectral range and end use. There are different materials available that excel in transmitting wavelengths in the ultraviolet, visible, and near-, mid- and far-infrared wavelength ranges. These include economical acrylic options to more costly alternatives for ultraviolet (UV) and long wave infrared (LWIR) applications.

This family of protective window products includes options for highly challenging environments, such as those with extremely high or low temperatures, excessive dust and debris, frequent exposure to scratching, and thermal or mechanical shock. Chemically resistant options are also available. Furthermore, the full range of precision mounting capabilities by MidOpt can be used to optimize adaptability, enabling protective windows to be effectively used in a diverse array of applications and configurations.

Also available are oleophobic (anti-oil, anti-smudge), hydrophobic and anti-reflective (A/R) coatings, which, when applied to a chosen protective window material, can enhance transmission and cleanability.

### The Strength of Sapphire

LP190 sapphire protective windows transmit wavelengths in the ultraviolet, visible, and short- to mid-wave infrared. This material is exceptionally durable and scratch resistant. With a surface built to withstand harsh environments, this material holds up even when exposed to heat, high impact, solvents, and other chemicals.

These qualities make LP190 windows an excellent fit for use in embedded vision systems, such as those used to monitor the operation of welding equipment, CNC metal-working equipment or forklifts. Utilizing a protective window that is durable enough for these taxing environments ensures maintenance of image clarity while reducing down time by minimizing the need for frequent replacement.

### Borofloat

LP286 protective windows are made of heat resistant Borofloat. Due to its low coefficient of thermal expansion and shock resistance, LP286 can withstand temperatures up to 450°C for prolonged periods of time. Economical yet durable, this product resists staining and damage from acids, alkalis and other harsh chemicals. It transmits wavelengths in the near-UV, visible and near-infrared ranges.

LP286 windows come standard with both rugged, broadband multilayer A/R coatings and a durable, high efficiency oleophobic coating.

Uncoated glass will only transmit about 91% of white light that passes through its surfaces. However, with A/R coatings, LP286 transmits 98% or more of incident light. In addition to minimizing reflection losses, A/R coatings improve performance in machine vision systems by enhancing contrast and eliminating ghost images.

The durable anti-smudge coatings by MidOpt found on LP286 and other protective windows repel oils and moisture, simplifying and greatly speeding up the process of cleaning these windows. This then minimizes scratching and surface degradation over time, enhancing longevity while preserving image quality.

### Fused Silica

With ultra-low thermal expansion and exceptional shock resistance, optically flat LP170 protective windows withstand operating temperatures up to 1,100°C. Quartzlike, ultra-pure synthetic fused silica has superior optical properties and excellent scratch and chemical resistance. These windows transmit light from UV to near-infrared wavelengths. LP171 windows are provided with wavelength-specific multilayer A/R coatings.

### Germanium

LP8000 protective windows have a 7.5-12-micron useful wavelength range and abrasion-resistant, diamond-like hard carbon A/R coatings. They are offered in sizes ranging up to 110-millimeter diameter.

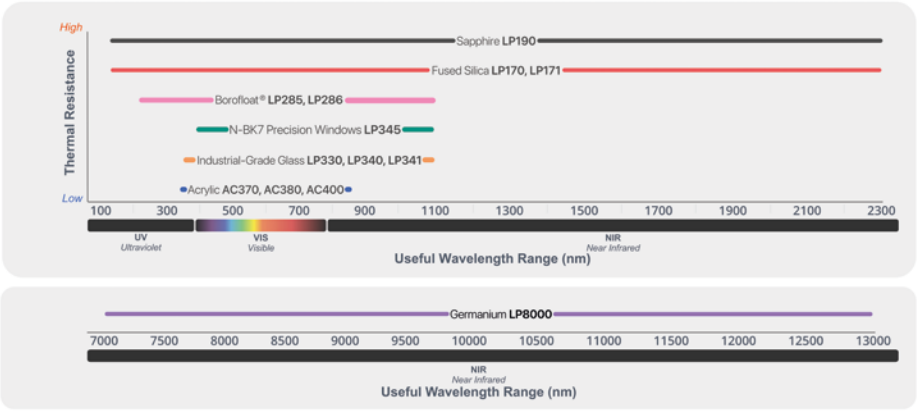
These precision ground flat windows represent a superior option for LWIR camera protection. They frequently find use in flame detection, medical, automotive, pyroelectric, defense, and space applications.

LP8000 windows resist alkalis, acids, and other chemicals. They are commonly installed in enclosures used to protect infrared imaging equipment from airborne particulates, humidity, saltwater and other harsh environments.

### Precision Windows

Made from optical crown glass, LP345 protective windows are double-side ground and polished to crystal clarity and precision optical flatness, then enhanced with rugged, multi-layer A/R coatings. They are free from image distortion, bubbles, and inclusions.

All images: Midwest Optical Systems




**Oleophobic, hydrophobic and anti-reflective (A/R) coatings enhance transmission and cleanability when applied to a chosen protective window material.**

LP345 windows have a peak transmission of at least 98% and can be used in the near-UV, visible and near-infrared ranges. These protective windows are environmentally stable and highly stain resistant.

## Cast Acrylic

MidOpt acrylic protective windows are made with highly transparent acrylic. Two affordable, durable, optical-grade options – AC370 and AC400 – are available for the visible to near-infrared wavelength ranges. Both come standard with multilayer anti-reflective and oleophobic coatings.

Most other acrylic materials that are utilized are made from cell cast acrylic. Cast acrylic substrates provides several key advantages over extruded acrylic. Cast material is better equipped to withstand constant contact with water and long-term mechanical loads. Additionally, it has a superior surface finish – with a surface roughness of better than 0.02 µ, reducing low angle distortion and providing high isotropic transmission (92% minimum), all while exhibiting minimal autofluorescence. When called for or specified, high vacuum evaporation methods are used to deposit coatings on both surfaces of the cast acrylic sheet material. Preparation for these coatings first requires that UV-cured hard coatings be applied, affording 50 times the scratch resistance of untreated acrylic and considerably improved pencil hardness (6H or better) over acrylic sheets that are treated with dip coatings. These coatings also make the acrylic sheet impervious to solvents, fuels and chemicals (such as acetone, methylene chloride and MEK).

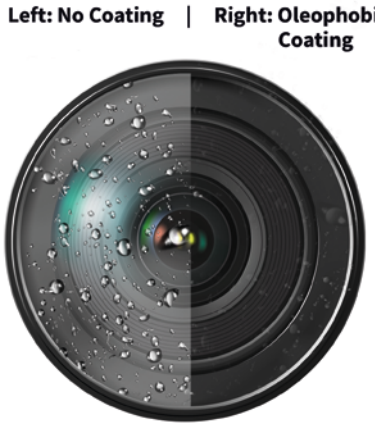
Aside from their lower cost, acrylic protective windows offer several other benefits. They weigh approximately half as much as comparable glass windows. Using precision laser cutting, they can be very quickly and inexpensively custom cut to almost any size and shape. And again, when hard-coated, they are highly resistant to abrasion and scratching.

MidOpt offers three stock thicknesses for clear acrylic protective windows, however custom thicknesses can also be made available. AC370 is one millimeter thick, while AC380/AC400 are offered in both two- and three-millimeter thicknesses.

All of these acrylic options block nearly all UV light, while also transmitting at least 98 % of visible light. They are suitable for covering screens, camera enclosures and on-axis lighting modules. Furthermore, they are essential for use in FDA/EFSA applications, where glass is prohibited, and thickness and weight must often be minimized.

## Industrial-Grade Glass

For applications in which glass can be utilized and is desired over acrylic, industrial-grade glass protective windows are another low-cost option. They can be used for visible to near-infrared applications. LP330 windows come without coatings, while LP340 windows have multilayer A/R coatings. LP341 material is provided with multilayer A/R and oleophobic coatings. ■




**LP286 windows come standard with both rugged, broadband multilayer A/R coatings and a durable, high efficiency oleophobic coating.**

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# Prototyping with Python

## A New Way of Developing Machine Vision Solutions with Common Vision Blox

**Prototyping is an important part of developing machine vision solutions. In addition to allowing developers to explore and learn about the problem in hand, it enables interim solutions to be presented to a customer or stakeholder to make sure everything is going in the right direction. In this way, everyone can see how the proposed solution would work and understand how a project is progressing with the added benefit that a better estimation of time and cost for the final solution can be provided. Speeding up the prototyping process is extremely beneficial to everyone involved. Three new object-oriented APIs, supporting C++, .NET and Python have been introduced in CVB2019 to provide a new way of developing machine vision solutions with Common Vision Blox.**

The new APIs are compatible with the existing CVB API, meaning that users can build on existing applications without having to re-write their codebase.

### The Benefits of Using Python

CVBpy brings the power and speed of CVB to a new group of users who are used to quick results and easy programming using Python. Python is a free, open source, interpreted, high-level, general-purpose programming language. Easy to learn and simple to use, Python is one of the most widely used programming languages. A recent survey showed that Python is not only one of the most loved languages by developers and but is also the most wanted language. It is portable so there are no concerns over compilers and hardware and it can run on embedded, Linux and Windows platforms. Because it is high level and so easy to learn it is possible to do many things very quickly, making it highly productive and therefore particularly suitable for prototyping. There are already Python frameworks in use in many application areas, including IoT, Machine Learning, Deep Learning, and Artificial Intelligence meaning that interfaces are available for an enormous range of libraries.

### Combining CVB and Python

To make the most of CVB's impressive capabilities, it was essential to create an optimized CVB Python binding. The general way of producing a Python interface is to generate it from a C interface using readily available tools. However, because Python can do so much more than C this is not the best approach since it omits a lot of powerful Python features. In principle, it is better to generate the Python binder from a more modern object orientated, potentially powerful architecture like C++. Although this is an improvement, it still lacks some of Python's special features since the generator takes one language and squeezes it into another, ignoring some of the key characteristics of both languages. The outcome usually contains the smallest set of common features, which is far from what a developer needs. The solution is to manually create the wrapper. Although this seems complex at first sight the development team at Stemmer Imaging, with an intimate knowledge of both CVB and Python, were able to do so quickly and efficiently.

The resulting CVBpy binder provides access to a lot of special Python features that can be used for programming and prototyping with CVB. These include:

- Explicit resource management. Python takes care of the management of resources such as memory or files and CVBpy supports this. This avoids the need to manually free up memory or close files or outsource the management of these resources. Explicit resource management is particularly important for imaging applications involving the acquisition or processing of large images and the use of high frame

```
import os
import cvb

with cvb.DeviceFactory.open(os.path.join(cvb.install_path(), "drivers", "CVMock.vin") as device:
    stream = device.stream
    stream.start()

    for i in range(10):
        image, status = stream.wait()
        if status == cvb.WaitStatus.Ok:
            print("Acquired image: " + str(i))

    stream.abort()
```

**This simple CVBpy 'hello world' example shows the code required to acquire a number of images.**

rates and or a large number of different devices which generate large amounts of data and require huge amounts of memory.

- Built-in documentation. Python features built-in documentation, so with CVBpy an IDE will display documentation help for each and every function. This is built into the library itself so there is no need to install separate documentation.
- Improved multithreading and async support for manual activities. This allows native threads to be started and the use of the asynchronous feature of Python, which is essentially working through an event handler.
- Stable API. Python offers a stable API, or ABI (Application Binary Interface) over the lifetime of Python 3, thanks to PEP 384. This means that CVBPy will run on every version of Python, from V3.5 to the current V3.8 and beyond with no adjustments required for future Python 3 versions.
- CVBpy provides an interface to Python's NumPy. NumPy adds support for large, multi- dimensional arrays and matrices, together with a large collection of high-level mathematical functions to operate on these arrays. The CVBpy interface allows images that have been acquired from a real device to be transferred directly into NumPy where any algorithms that have been developed there can be applied.
- UI using PySide2. Imaging applications require a suitable display capability to show the original images and the effects of any algorithms that have been developed. As Python does not come with any user interface itself, CVBpy includes an interface to PySide2 which is a Qt5 wrapper for Python for creating UIs.

## Object Orientation

CVBpy can interact with a number of basic classes from an object orientation point of view. The main entry point for accessing hardware devices, such as the camera, is the device factory, which also provides access to different types of devices. There is a general interface to video devices with real hardware behind them or to non-streaming devices that just have a control path. There are also emulated devices with defined data – either as a classic media file or in an emulation file format. Devices can have one or multiple streams and the use of multiple streams is under development but there is usually at least one stream available. On this stream there is a ring buffer into which images are acquired. This stream provides the most recent image for processing. The image itself consists of multiple planes. The device itself has node maps such as a GenAPI node map for the control path. At different levels, the maps and the nodes and the features can be obtained from each device which describes itself through an XML. In addition, there are some convenient interfaces on the devices for easier access of common features.

## Practical Examples of CVBpy

One of the simplest examples is the Python 'hello world' program. This CVBpy 'hello world' example shows the code required to acquire a number of images. It is quite an easy piece of code. The first action is to open a mock-up device from the device factory and get a stream from it. The stream is then started and acquires 10 images. The status of each image is checked to make sure that it is OK and then the number of the image is printed out. To clean up afterwards, the acquisition is simply aborted.

For more advanced examples, a live display would be required that is more responsive and adaptable. The UI application needs to be multithreaded to allow the camera to run asynchronously to the UI. Generic handling of acquisition hardware is also required and for best practice the UI should be separated from the logic code. The video demonstrates interfacing with the UI and shows how easy it is to set up a single stream image display from a device with just 26 lines of code and link it to a UI.

## Summary

The advent of Python support in CVB brings new possibilities for scripting applications that can be modified at runtime, greatly speeding up the prototyping process. Working with CVBpy is just the same as working with common Python modules, opening up the benefits of CVB to the latest generation of programmers and developers. ■

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All images: Stemmer Imaging


Image: Ximea

# Flexing the Muscles

## Scientific Imaging Capability and High Data Rates

**A new PCI Express interface for cameras achieves low latency from sensor to operating computer for optimum processing capability and speed.**

The MX377 camera, the latest product from Ximea, features one of the largest sCMOS sensors available today. The Gpixel Gsense 6060 with 37.7 million 10 µm pixels offers imaging performance on par with the best CCDs – finally – in a high-speed CMOS architecture.

Existing CCDs have thus far remained the go-to technology for scientific measurements, in spite of being unable to match the pace of CMOS innovation. The MX377 camera delivers scientific imaging capabilities with high dynamic range and low noise – at high speed. The MX camera line utilizes a multi-lane PCIe interface which is able to deliver data at the maximum rates the sensor is capable of. The camera was also designed with cooling for low light level applications.

The camera can be provided with several versions of the Gsense6060 sensor, including frontside (FSI) or backside (BSI) illuminated models.

With the sCMOS BSI sensor, the camera reaches a maximum quantum efficiency of 95 percent. Due to the sensor format of 60 x 60 mm, 6 k by 6 k resolution and 10 µm pixel size, it is a perfect fit for applications demanding a medium to large format sensor. The output signal from the Gsense 6060 pixels is processed by two readout amplifiers (hi and lo) allowing an HDR readout (2 x 12 bit ADC) with up to 90 dB dynamic range. All this with a frame rate of up to 44 fps and a full well capacity of 120 Ke-.

### Abundance of Image Data

The PCIe interface delivers data with low latency from the sensor to the operating computer's RAM (or GPU) for optimum processing capability and speed. The sensor itself has a number of interesting properties with high dynamic range (FWC close what is expected from CCDs) and dual amplifiers for simultaneous integration of the imagery to deliver high bit depth information on the contents of the image.

The MX377 was designed with a wide range of scientific applications in mind, high energy physics, life science, TEM, astronomy, space situational awareness (SSA) and others. These and other applications will benefit from the combination of high-speed CMOS performance with CCD like data quality in dynamic range and noise, further improved by the availability of either air or water-based cooling options to reduce thermal noise for long exposures. This large format sensor and all its capabilities comes in a very compact package, compatible with M95 lenses. The compact CNC machined camera housing is designed with Ximea's core principles of remaining small and fast in mind.

Ximea is known as a reliable and professional innovator in the markets of industrial and scientific imaging. From small high-performance cameras to embedded and multi-camera systems, specialized products for challenging and advanced demands are part of the portfolio. Especially compact form factors, robust housings and very fast cameras are considered the company's core competencies. With more than two decades of experience its engineers are constantly setting new standards for the entire industry through designing solutions for OEM-projects and off the shelf products. Virtual reality, industrial, scientific, and embedded applications all benefit from our cameras and software tools. Ximea serves all types of tech companies around the world, from global players to small start-ups. Its camera technologies allow the customers to improve their products and to enable their applications. Facing challenges together with clients to solve individual needs with standard products and custom designs is one of the company's essential philosophies.■

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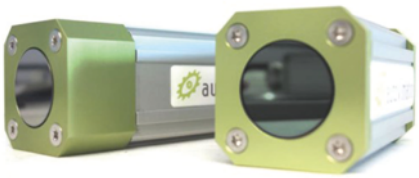
## Colibri housing now available with germanium disc

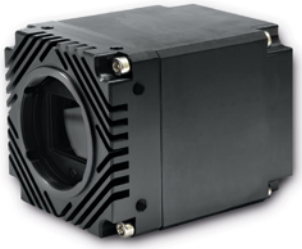


As a new option, Autovimation now offers its Colibri housing with a DLC and anti-reflective coated (7-14 µm) germanium disc. Thanks to special seals, 28 mm of the 30 mm disc diameter are available as a free orifice diameter. This lowers the costs for the germanium window and enables a cheaper housing for small infrared or thermal imaging cameras. The compact Colibri protective camera housings with IP66 are the ideal solution for space-critical applications. They are suitable for cameras with a cross-section of 29 x 29 mm or 30 x 30 mm and for lenses up to 39 mm in diameter. The weight of around 400 g predestines the models for mobile applications. With only 50 x 50 mm (W x H) and 117 mm to 211 mm total length, the housing is only slightly larger than the camera to be protected with lens and connection. The possibility of flexibly positioning the camera in the housing means that the front lens can be placed directly behind the germanium disk. Thanks to the large aperture, wide-angle lenses can also be used without any problems. At the same time, Autovimation's range of front covers of different depths opens up the option of using cameras with both C and S-mount lenses: C-mount lenses can be used with conventional deep standard front covers for easy access to the focus and aperture ring protrude by 23 mm from the housing profile. With the only 6 mm flat Colibri front cover, however, S-mount lenses are mounted directly behind the pane to avoid corner shading. The patented Heatguide / Quicklock camera mount has been simplified and miniaturized by Autovimation so that the camera can be attached to the housing from only one side.

**www.autovimation.com**

## High speed camera with Sony 4th Gen Pregius S sensors

The Atlas10 camera features Sony's 4th Gen Pregius S CMOS sensors, capable of 1.2Gb/s bandwidth over 10GBASE-T PoE and delivering a new level of imaging performance for high speed applications. Sony's proprietary back-illuminated pixel structure enables a reduction in pixel size to 2.74 µm while still maintaining excellent image quality compared to previous Sony Pregius generations. The first model in the Atlas10 camera series has the 24.5 MP Sony Pregius S IMX530 global shutter 4/3" image sensor, which offers up to 51 frames per second at full resolution. Subsequent models include the



20.4 MP featuring the IMX531 and the 16.2 MP featuring the IMX532. The 24.5 MP Atlas10 is now available for order.

**www.thinklucid.com**

## MIPI camera and driver for NVIDIA developer kit

Vision Components has added a new starter pack to its MIPI product range for embedded vision projects: users simply connect the camera module and MIPI cable to their Nvidia Jetson Nano Developer Kit, and they are ready set to start application development. Additional accessories are included, notably the necessary driver, allowing users to save development time and costs.

Customers have the choice of sensor from a large range of machine vision sensors with a MIPI interface. Currently, sensor resolutions up to 20 megapixels are available. The starter pack also includes a lens holder (C/CS-mount or S-mount) and a shielded 200 mm FPC cable. Vision Components developed the cables specifically for the MIPI camera modules, ensuring noise-free data transmission and high bandwidths. The German company provides the driver and source code free of charge, allowing users to make their own adjustments. NVIDIA Jetson Nano is a compact computer for embedded projects utilizing AI. In combination with the VC MIPI starter pack with guaranteed long-term availability, it is ideal for vision applications such as image classification and object detection.

**www.vision-components.com**

# Digital Upgrade

## Upgrade Package Transforms Microscopes into Digital Systems

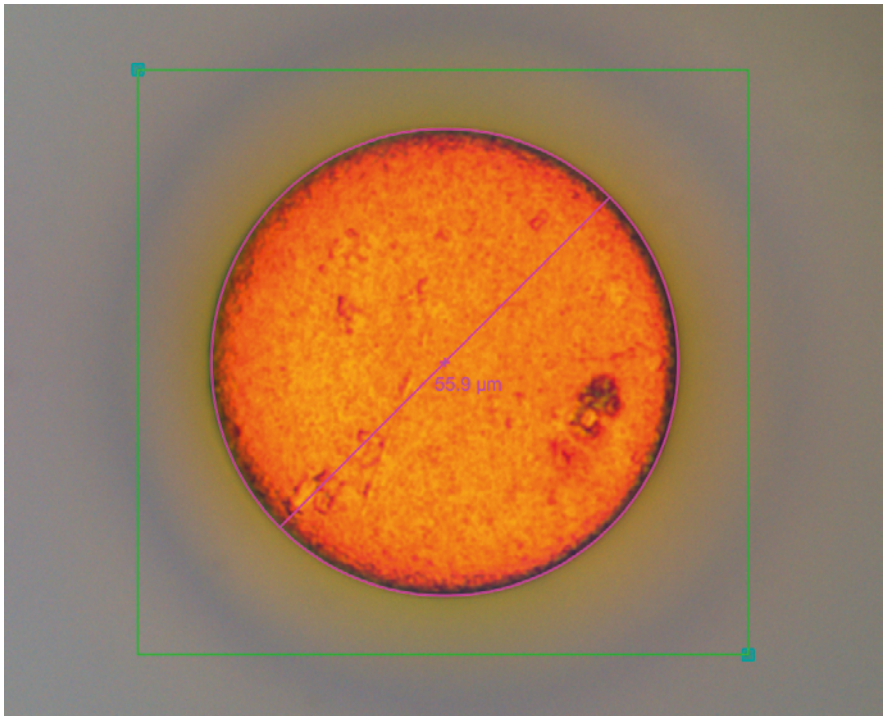



Image: Invigon

**Microscopes are used at practically every research institution and every company. Due to the long service life of the optical and mechanical systems, many of these microscopes are still analog. However, companies do not necessarily have to replace existing microscopes to make their systems fit for a modern digital workflow. With the Autoaim microscope upgrade from Invigon, consisting of a powerful industrial camera, a microscope software, and the matching accessories, almost every microscopy system can be upgraded to be state-of-the-art again.**

A digital camera offers notable advantages for microscopy applications – instead of looking through an ocular lens, microscopic images can be viewed on a monitor and microscopic structures can be measured on the PC. Subsequent image processing is also possible. Therefore, in this era of digitization, many users who already own a good microscope are looking for an appropriate digital solution. However, to make full use of a microscope camera, users additionally require a software that controls the camera and that includes the functions required for the corresponding application. A well-coordinated overall solution is thus needed. This is exactly what Invigon, a software development and industrial machine vision company, offers in the form of the Autoaim microscope upgrade package. It contains everything users need to upgrade their existing microscope system to a modern digital system. This includes both the powerful and intuitive microscope software as well as a high-performance, 5-megapixel CMOS camera of the CX series from Baumer including all accessories required for connection to the PC and calibration. The cameras provide users with high-resolution live images that are smooth and highly responsive at the same time. In combination with the modular and flexible software, this allows users from the industrial or scientific sector to digitize their microscopy solutions and to automate their measurements.

### Flexible and Modular

With its automatic pattern recognition and easy-to-reproduce measuring functions, Autoaim is used by research institutions, medium-sized businesses, and large corporations. "Our customers extol the intuitive handling and the workflows that can be matched to their tasks," says Dr. Enrico Seise, managing director of Invigon. The principle of "recipe-based automation" allows all users, even those without programming experience, to automate their measurement processes – this is done by carrying out the individual measurement steps once in a teach-in process using a normal sample. If this process only included one of several areas to be measured, the measurement range can be subsequently expanded via the software. Once taught in, this "recipe" can be applied to many similar samples. In the case of position deviations, the integrated pattern recognition automatically recognizes the structures to be measured and measures the relevant areas. Based on a variety of functions, the simple creation of "recipes", and modular hardware compatibility, a great variety of applications ranging from biology and life sciences through industrial material inspection and up to the inspection of electronic circuit boards can be addressed. Extensive export options always allow a comprehensive documentation of all measurement results.


Image: Baumer

**With more than 115 models, the CX series from Baumer offers GigE and USB 3.0 cameras with global and rolling shutter CMOS sensors for cross-industry applications.**

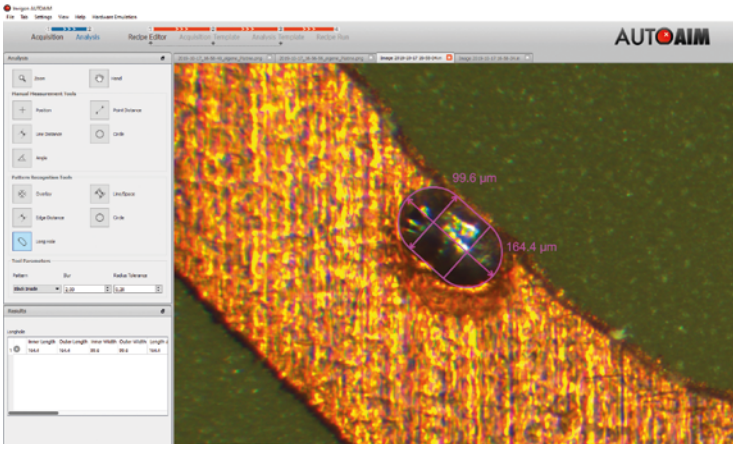



Image: Invigon

**The software Autoaim captures and measures defects of copper conductive tracks on electronic circuit boards to support users with quality control.**

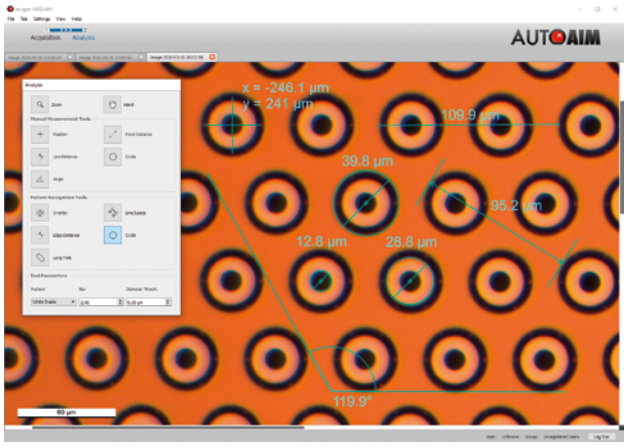



Image: Invigon

**In the analysis view of the Autoaim microscopy software, circular structures on wafers can be characterized in various ways, e.g. via positions, distances, angles, or circle diameters.**

## Digital Upgrade

"Often, microscopes with and without cameras have already been an integral part of the work of research institutions and quality testing at companies for many years. However, due to the outdated technology, workflows cannot be digitized at all or only insufficiently," is how Dr. Seise describes the need to upgrade microscope systems on the market. The upgrade package gives these users access to the most current technology. According to Dr. Seise, it takes less than an hour to install all components and to customize the software to allow digital measuring and documenting to commence quickly and easily.

Even though Autoaim can be used in conjunction with a variety of hardware options, Invigon has deliberately opted to include the camera models VCXU-51C and VCXU-51M from Baumer in the upgrade package as standard. "A high-quality camera that functions reliably was important to us. After all, we want to produce our package in industrial quality, and it should function satisfactorily for the customers." The cameras were also convincing in terms of software. "As software developers, we are of course strongly interested in the software that is included with the camera, as this practically becomes part of our software," emphasizes Dr. Seise. "This is why good documentation and a high degree of maturity are important to us, which Baumer provides us."

## Pixel Binning Also in Color

In terms of hardware, the models with their 5-megapixel resolution also had much to offer. To allow observation of what happens to a sample underneath the microscope, the live image of the camera must be smooth and respond quickly to changes. However, high-resolution images that also convey color information create vast amounts of data that are particularly challenging to older computers. To allow a smooth picture to be rendered even on a PC that is ten years old, Invigon has greatly optimized its software, which is also demanding on the camera. "The cameras from Baumer reliably provide more than 30 frames/s and can also combine several pixels via pixel binning when the images are captured in color. This can only be accomplished by very few cameras on the market, because other suppliers economize in this regard, while Baumer offers such additional functions as standard," explains Dr. Seise. Another advantage is the availability of the support team in case of questions. "You can even call them on a late Friday afternoon and receive an answer. And when we receive a customer inquiry with specific wishes, we can conveniently borrow a camera for testing purposes. This makes it easier for us to react flexibly and quickly to customer wishes," says Dr. Seise. Invigon has been offering the upgrade package since late 2019 with consistently positive feedback so far. Dr. Seise is pleased: "This way, we contribute to the digitization of industrial quality assurance and research without having to replace existing microscopes. This is a win-win situation for all involved parties." ■

**»Microscopes with and without cameras are an integral part of the work of research institutions and quality testing at companies. With the upgrade package, workflows can now be digitized.«**

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# “Focus on the Image Processing Task, This Is What We Are All About”

Interview with Carsten Strampe, Managing Director of Imago Technologies

**What are the major growth areas in the machine vision industry? What are the effects of the cancellation of Vision 2020 and how do online-based alternatives compare? David Löh, deputy editor-in-chief of inspect, has talked about this with Carsten Strampe, managing director of Imago Technologies, manufacturer of embedded systems. In the course of this, Strampe also explains the latest product from his company: the matchbox-sized VisionSensor.**

**inspect: Imago has recently inaugurated a new production building. With which products for which industry will this be utilized in the future?**
**Carsten Strampe:** We produce our entire portfolio there for our series machine manufacturing customers in various industries.

**inspect: Where do you see the biggest growth areas for machine vision?**
**Strampe:** Technically speaking, in easy to-operate systems, as small and compact as possible. In both respects we rely on the event-based sensors in our Linux-based VisionCam.

**inspect: You also want to grow more internationally with Imago. Which countries or regions do you have in mind?**
**Strampe:** Classic industrialized countries such as the USA, Japan, Korea and China.

**inspect: How has Imago come through the Corona crisis so far?**
**Strampe:** Good altogether. Our second building has created space and thus distance, no one has fallen ill, and declines in sales have been limited.

**inspect: To what extent has the Corona pandemic changed the way we think about manufacturing abroad or at home?**
**Strampe:** Not at all. We have a worldwide procurement system and know that domestic suppliers could be competitive. Competitiveness is not only defined by prices; you simply must want to make an effort.

**inspect: Which measures have helped you to maintain business activity?**
**Strampe:** In essence, there was a lot of space, i.e. many individual offices. The so important

All images: Imago

communication among the employees never really broke down. A technology company thrives on ideas, the exchange of viewpoints and differences of opinion, and this only functions to a limited extent in video conferences.

**inspect: How do you assess the impact of the cancelled trade fairs, especially the Vision trade fair, on the machine vision industry?**
**Strampe:** Backward step. I think it's a great pity – the trade show every two years is a communication platform for and with customers. Vision is a real knowledge hall with many experts and high-quality discussions. I wonder why it can't take place in spring 2021.

**inspect: Can virtual events partially replace face-to-face events?**
**Strampe:** Not at all. Ask yourself: Why is the German trade fair landscape in particular still flourishing? Why do people fly around the globe to visit a trade fair? It is about trust in companies and people. I have been finding information itself on the Internet for decades.

» A technology company thrives on ideas, the exchange of viewpoints and differences of opinion, and this only functions to a limited extent in video conferences.«

**inspect: What do you think of so-called hybrid events?**
**Strampe:** From a technical point of view, the expectation of further sources of information is goal-oriented, as for example webinars or explanatory videos. Perhaps the areas for customer talks at the booth will become larger and live demos will decrease.

**inspect: Let's talk about the new vision sensor from Imago: What are the most important features of your vision system?**
**Strampe:** Miniaturization is a keyword – but especially the View IT tool, which greatly simplifies and accelerates the development of individual solutions. No more C++, no more wasting time with the GUI. Focusing on the image processing task, that is what we are all about.

**inspect: For which user group is it suitable?**
**Strampe:** Even beginners can get a hang on it. But they should also be adequately trained, i.e. have heard about image processing in their studies. You still need a portion of imagination about what image processing algorithms do in the image. With this basic understanding, you can then also come to robustly functioning solutions.

**inspect: For which applications is the vision sensor particularly suitable?**
**Strampe:** The applications are not limited. The resolution of the 2-MPixel sensor allows the solution of many everyday tasks, the quad-core processor calculates even more complex algorithms. It is progress – but with a complex pattern matching in 2 ms process time – it would be better to go in the direction of Box-IPC.

**inspect: How did Imago manage to make the vision sensor so compact?**
**Strampe:** Just as Coca-Cola does not reveal its recipe, we don't either. So, the answer is: through the expertise of the Imago Technologies staff.

**inspect: What products do you have in the development pipeline for next year?**
**Strampe:** With the Visionsensor the camera resolution is increased, our event-based Visioncam becomes smaller, deep learning requires inference computers and applications merge even more with hardware requirements, keyword embedded machine vision. But we leave the concrete details to the imagination of our engineers and customers. (dl) ■

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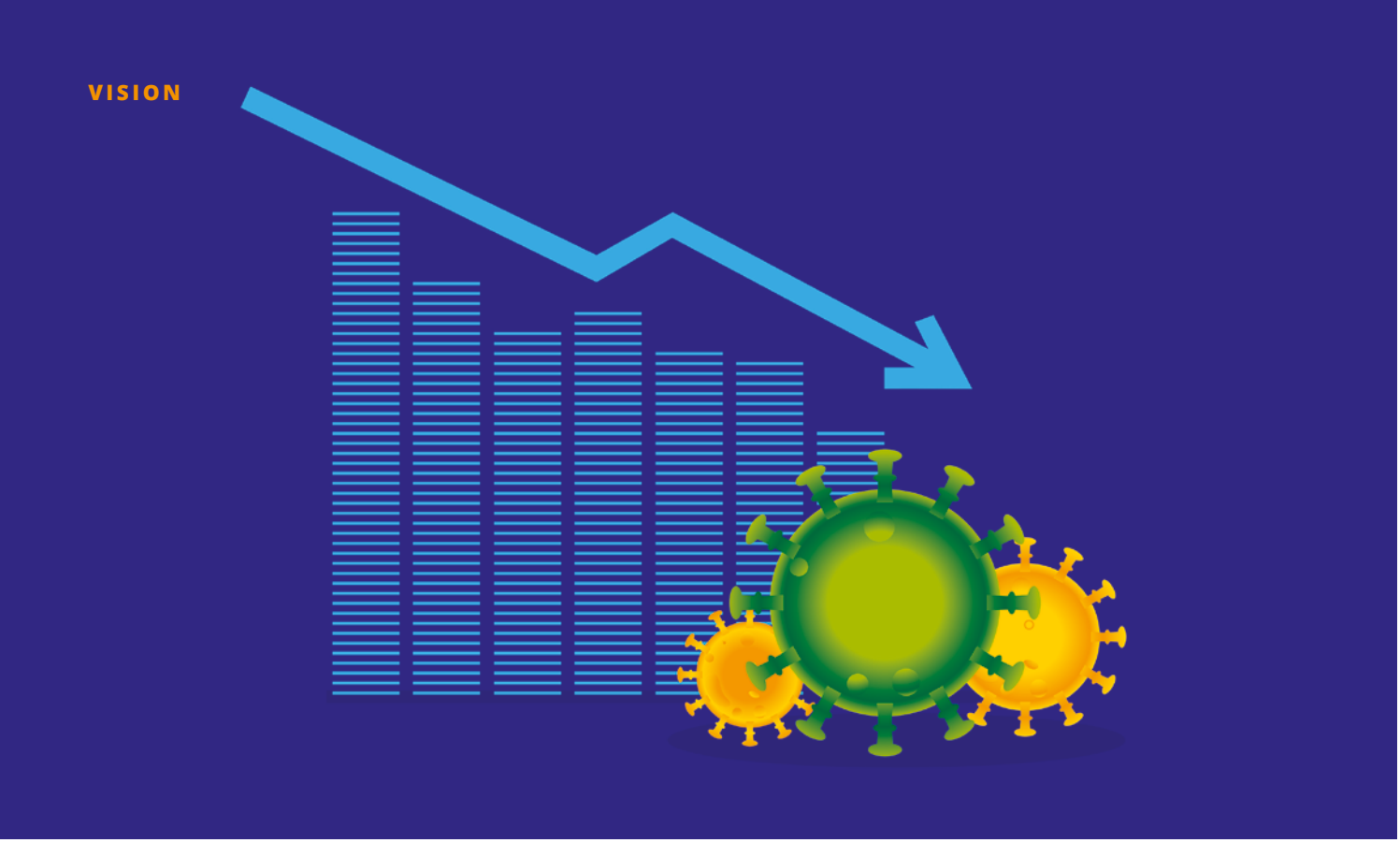


Image: Ahmet Aglamaz - stock.adobe.com

# EMVA Corona Survey

## Association Investigates Covid-19 Impacts on the Machine Vision Industry

**During April and June 2020, the EMVA conducted a bipartite survey on the effects of the Covid-19 crisis for the machine vision industry. A standardized questionnaire was distributed by email to a wide range of industry participants, both EMVA member companies and from the wider industry. The results were complemented and verified by a series of telephone interviews with senior managers and executives from selected companies representing as wide a cross section of the industry as possible.**

### Beneficiaries versus Sufferers

The majority of participants expect a U-shaped economic development during and after the crisis. On average the survey participants anticipate the machine vision industry to contract by 17 % in 2020. Customer industries related to health matters along with the food industry are expected to benefit from in the crisis while the automotive industry is seen to suffer most. Machine vision supply chains are not yet severely in danger. Working from home is proving to be an efficient tool to maintain business operations, whereas trade shows and other business meeting opportunities are dearly missed. Although Covid-19 certainly places serious constraints to the overall economic outlook for many machine vision enterprises, participants of the survey have also identified possible opportunities for the machine vision industry arising from the global crisis.

### The U-Curve Dominates

At the time the answers were provided, the impacts of the Covid-19 pandemic were not yet consistently severe across the world. However, a dominant concern which emerged in the machine vision industry was about future economic development. Almost 44 % of the answers to the questions about which overall economic development the Corona situation will take, anticipated a U-curve with a strong economic decline, a lasting period of recession with only then at the end a strong recovery (Fig. 1). 24 % indicated a double-dip W-recession caused by firstly catch-up investments after the lockdown followed by a slow-down due to missing order income during the lockdown period; and a possible threat of a second Coronavirus infection wave. 17 % expect a strong decline with no signs of fast recovery (L-curve); and only some 15 %, believe in a strong and fast recovery after the sharp recession (V-curve) .

This lack of trust in a quick and fast recovery is reinforced by many opinions gathered in the direct interviews, and also by the results of another EMVA survey, the continuous EMVA Quarterly Machine Vision Sales Report. That survey saw the machine vision industry already contracting in the fourth quarter of 2019 and first quarter of 2020 and expectations of much stronger effects of the global pandemic during the second half of this year. Participants of the recent Corona-survey shared this opinion, but at least from component manufacturer and distributor perspectives it was also noted that directly after the pandemic reached its peak in April, customers ordered twice or more the amount they needed fearing that next time they would not get the products any more due to stock and supply chain concerns. However, the majority of the participating companies believe that pre-crisis level sales will not be reached before end of the year 2020, or even one year after peak

» Almost 44 % of the answers to the questions about which overall economic development the Corona situation will take, anticipated a U-curve with a strong economic decline, a lasting period of recession with only then at the end a strong recovery.«

crisis this spring (Fig. 2). Asked about their personal business expectations 56 % of the companies stated that Covid-19 has resulted in a net contraction of their business (Fig. 3).

### Caution in the Second Half-Year

Most of the companies approached were cautious about the second half of 2020 and expected a drop-in demand for this period. Even those who generally experience strong sales to the Asia-Pacific region are skeptical, since many consumer goods produced in the region may not find buyers in the western markets due to the ongoing buying restraint. On average the survey participants expect the machine vision industry to contract by 17 % in 2020.

Although countries such as Italy, Spain, the UK and France were hit much harder from Covid-19 than others there were no uniform statements that the drop-in machine vision sales directly correlated with the intensity of how affected a particular country was. One explanation is that through home office at least a part of the orders was still placed which enabled a base level of business continuity.

Another question in the survey was how long the individual company could survive a lock-down period as seen in March and April. Here, over 80 % percent of the companies stated that their enterprise would survive six months or longer until it would ultimately threaten their survival, a strong statement of the underlying strength of businesses within the machine vision sector.

### Customer Industries: Winners and Losers

The most affected industry vertical identified by the survey participants was the automotive industry. However, part of the picture at closer examination is also the fact that the shutdown of automotive production lines offered ways for vision system integrators to move installations up in time where during normal operation only small slots of line standstill are available. This provided contracts to integrators during the first shutdown period. Other industries strongly affected include the machine building industry and the area of sports and entertainment. Furthermore, parts of the glass industry were hit by closed restaurants and bars with less demand in glass bottles.

The main customer industries that the survey participants expect to feel no impact, or even benefit from the Corona pandemic, are the sectors of medical devices, health care and life sciences; followed by the pharmaceutical and cosmetics industry; the food and beverage industry where several participants indicated that sales even increased due to higher demand of automated farming and food production; and the logistics and postal sorting industry.

**Figure 1:**

**Which overall economic development do you expect the current crisis to take?**

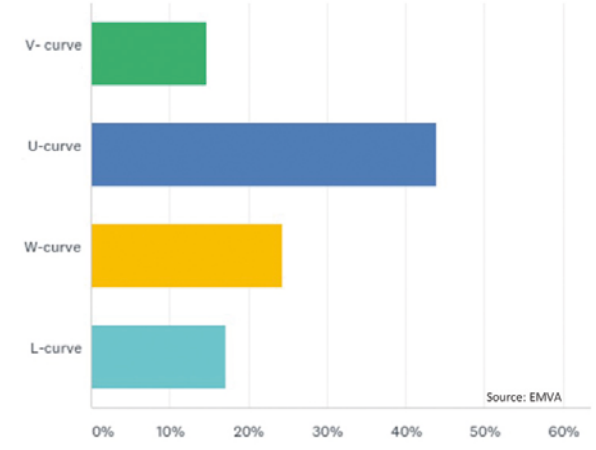


Figure 2:

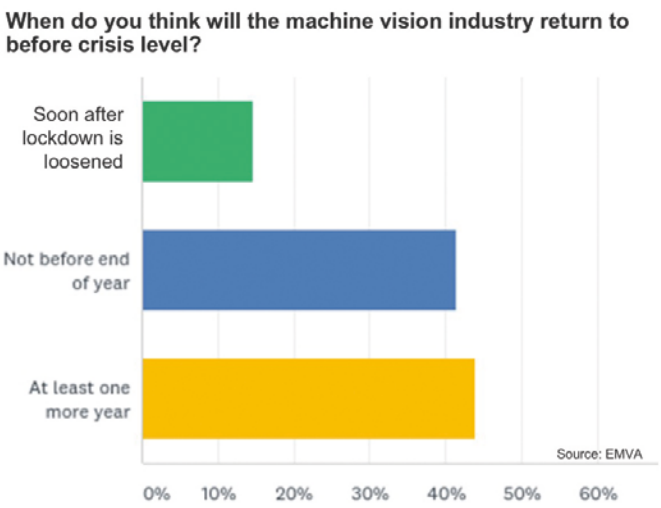
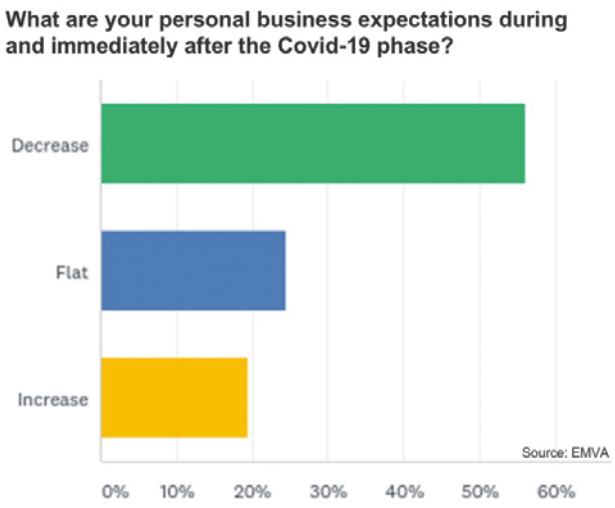



Figure 3:




## Supply Chains in Danger?

Another issue during the current situation is the stability of supply chains, potentially impacted by closed borders and reduced air traffic. At time of answering the Covid-19 survey a clear majority of 56 % answered that their supply chains were not yet in danger; but another 31 % stated that foreseeably they would have difficulties here and 12 % said that the corona crisis had already heavily impacted on the supply of components.

Disruptions in the supply chain were also reported during the direct interviews. Shortages and delays in delivery mainly in general electronic components and industrial PCs coming from China were reported due to the extension of the Chinese New Year break into March. Additionally, shipment costs from Asia rose due to lack of transport space in China, Korea and Singapore. Long lead times are expected when demand increases, and reduced production capacities may not be able to support the sudden increase in demand. By way of example, companies in France reported that a large logistics provider stopped collection and delivery of parcels for almost the entire April.

Overall these situations may lead to companies rethinking their supply structure and further diversify through building up alternatives in different countries.

## Home Office Stands the Test but Missing Meeting Opportunities

One remarkable output of the interview series was the almost unanimous opinion how efficient working from home office has been, with the participants indicating that the majority of staff was fully functional after a short transitional period. In addition, most interview partners also stated that travel activities to suppliers and customers have been successfully replaced by video conference tools, saving both time and cost. Staff were also benefitting from a reduction in commuting between home and office, which is either not possible or no longer necessary. This led to the common perception that even after the current restrictions are eased, a notable part of these new digital meeting tools will remain, and travel activities will be reduced when compared to the situation prior to the crisis. This is how one of our interviewee's summarized this new working experience: "People are getting used to work without travelling, and companies will see how much money was saved during the lockdown and there will be an element of keeping things in video meetings instead of travelling."

Of course, these new habits do not fully replace personal visits at a customer, the on-site expertise given by integrators or even cultural habits of face-to-face meetings and dinner invitations as part of the respect to customer typical across Europe.

More negative impact in the social lockdown is seen in the lack of trade shows. "No trade show means no new contacts" and "virtual shows are one thing, but you need to see the product live" together with "we are humans and want to interact personally" were statements summarizing the fear that with no active new business development on trade show floors the lack of new leads could contribute to the sales drop in the second half year. But not everyone approached were missing trade shows as some companies also benefit from earlier concentration of their customer interaction through the internet and tools like search engine optimization.

## Opportunities for Vision Technology

"Any event like this forces change" – "We look at the crisis as an opportunity" are two statements given about how Covid-19 might impact the companies in machine vision industry. One such opportunity is what an interview partner described as "seeding period" in R&D. What he meant was that due to the lockdown period with daily work was on hold, the opportunity was open to focus and concentrate the resources of the company on R&D projects to invest in innovation.

In this light, the biggest opportunities are seen in the acceleration of production flexibility through robotics and process and factory automation, where the machine vision as the "eye of industry 4.0" plays a key role in the digitalization of factories. But in order to profit from these opportunities it was also stated that the machine vision industry must present itself as enabler of higher profitability.

These opinions are reflected in the answers given in the survey when asked where the machine vision industry can eventually benefit from the impacts of Covid-19 through accelerated automation and digitalization. With 68 % of respondents providing a positive response, more than two thirds of the survey participants share this point of view.

Another side effect of the lockdown and closed borders could also be relocation of production analogous to the "reshoring" movement in the USA several years ago. This applies for instance for the pharmaceutical industry in France and Germany which now seeks to relocate production from Asia to their home countries; an opportunity also for the machine vision industry since quality inspection is a key element in producing pharmaceuticals.

No matter where in the machine vision value chain a company is, one advice from an interview partner is probably applicable for all enterprises: "The Corona crisis must be taken as an opportunity for all companies to scrutinize their business model and efficiency." ■

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## Fourth generation of Sony CMOS sensors integrated

IDS integrates the high-performance, extremely high-resolution sensor IMX541 from the Pregius S series into the uEye SE camera family. The large-format 1.1" CMOS sensor has 20.35 MP and will soon be available both as board-level camera versions and as models with housing.

Pregius S, the fourth generation of CMOS image sensors from Sony, makes BSI ("Back Side Illuminated") technology available for the first time in global shutter sensors. The advantages include a smaller pixel size (only 2.74 µm - thus enabling significantly higher pixel density), higher resolution and also improved quantum efficiency and sensitivity. The new camera models hence deliver high image quality that leaves nothing to be desired even in demanding machine vision applications such as surface inspections, detailed image evaluation in medical technology or use in the traffic sector.

The compact industrial cameras are therefore also a sensible alternative to cameras with similar high-resolution but large-format sensors, for which F-mount lenses are usually required. With the uEye SE models, C-mount lenses can be used – which means considerable cost savings. Thanks to the USB3 Vision interface, the cameras are also Vision Standard-compliant and can therefore be used conveniently with our SDK IDS peak, for example.


**www.ids-imaging.de**

## Embedded vision in matchbox format

Embedded vision is the keyword when it comes to compact and at the same time powerful image processing systems. It can be integrated into small devices or in places where there is little space. This means that many new fields of application can now be opened up in which intelligent image processing systems or classic IPCs have previously reached their limits.

The Visionsensor PV3 from Imago, with its dimensions of 53x45mm, also fits into tight spaces. In addition to a camera with 2 megapixels resolution, the power package also houses a high-performance Linux Quadcore processor. This means that the computing power has more than doubled compared to the previous model. The embedded vision system with a small form factor (SFF) enables fast, reliable and high quality inspection in numerous industrial sectors, such as Control of the best-before date, barcode and dotcode reading or label control in the food and beverage industry. Or, for example, the permanent scanning of labels and checking of the printed content when labeling.

**www.imago-technologies.com**

## Sony launches visible and SWIR based imagers

Sony Semiconductor Solutions has launched two new image sensors that include both the visible and short wavelength infrared (SWIR) ranges in captured images. The IMX990 and IMX991 sensors utilize the industry's smallest 5µm pixel size of any InGaAs based sensor.

These sensors leverage Sony's original Senswir technology and are SXGA 1/2-type and VGA 1/4-type imagers that are being made available by Framos. Both these products utilize a 5µm square pixel that can capture light wavelengths that are both visible and nonvisible to the human eye. The spectral response of these sensors is between 400nm-1700nm allowing them to detect and see into the SWIR range while not sacrificing too much within the visible spectrum ranges. This is partially achieved through thinning of the top Indium Phosphide (InP) layer, placed above the indium gallium arsenide (InGaAs). This thinning allowing the shorter wavelengths, those in the blue light range, to pass through and be absorbed in the sensitive InGaAs region. This sensing layer is then connected to the readout circuitry through Cu-Cu connections that help them deliver high quality images in a compact design. Additional outer memory provides real-time optical black (OPB) dark level information without the need for external dark current correction (DCC).

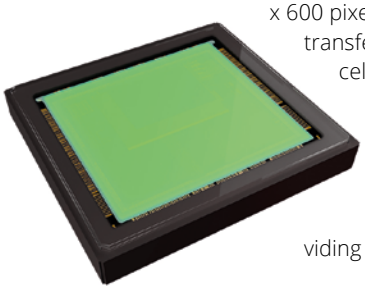
The IMX990 1.34 MP sensor has a 1,296 x 1,032 active pixel array that can be streamed at 130 fps @ 8 bits, 120 fps @ 10 bits and 70 fps @ 12 bits. The IMX991 0.34 MP sensor has a 656 x 520 active pixel array that can be streamed at 250 fps @ 8 bits, 240 fps @ 10 bits and 130 fps @ 12 bits. The smaller pixel size of these imagers combined with Sony's sensor stacking experience provides for a very compact design for their packages, thereby reducing costs for similarly designed SWIR based cameras. Both a ceramic PGA with built-in thermoelectric cooling (TEC) and a ceramic LGA package will be available. For those with experience in incorporating Sony's other Pregius based sensors, these new chips support almost the same functionalities thus accelerating their incorporation into existing designs and eliminating the need for analog circuitry typically needed for SWIR based camera designs. Global shutters, ROI and digital thermometers are standard functions available with these products.

**www.framos.com**

## ToF sensor for next generation 3D vision systems

Teledyne e2v announces Hydra 3D, its new Time-of-Flight (ToF) CMOS image sensor, tailored for 3D detection and distance measurement. The sensor supports the latest industrial applications, including vision guided robotics, logistics and automated guided vehicles. Hydra 3D's high resolution and flexible configuration, combined with its on-chip HDR, make it ideal for outdoor applications such as surveillance, ITS, building construction and drones.

The sensor features a 10 µm three-tap cutting-edge pixel, designed with Teledyne e2v's proprietary CMOS technology and produced by Tower Semiconductor, the leader in high-value analog semiconductor foundry solutions. Incorporating a resolution of 832 x 600 pixels, Hydra3D provides very fast transfer times starting from 20ns, excellent demodulation contrast and sensitivity. The sensor can be operated in real-time at short, mid and long-range distances, in both indoor and outdoor conditions, while providing high temporal precision.



**www.teledynedalsa.com**

## Smart camera for AI machine vision deployment

Adlink has launched the Neon-2000-JT2 AI-enabled smart camera series to make machine vision deployment for AI-based factory automation easier. Powered by Nvidia Jetson TX2 AI modules the new smart camera series features all-in-one design, a small footprint and a pre-installed vision software set to reduce the complexity of AI machine vision development and integration.

The Neon-2000-JT2 helps increase production efficiency in labor-intensive manufacturing industries such as food and beverage, consumer packaged goods, farming and agriculture

where quality insurance and inspection are critical to production success. One customer leveraging an AI machine vision solution for product inspection was able to inspect 50x more product and achieve a 95 % inspection accuracy, 3x more than previously possible. Adlink expects customers to see even greater results with the NEON-2000-JT2 series.

The AI-enabled smart camera includes sensor and GPU module integration, FPGA based DI/O design, a pre-installed deep learning software set and ready to use sample code for quick vision application development. Its safety certified by both the CE (European Commission) and FCC (United States Federal Communications Commission), and validated for shock, vibration and temperature stability for worry-free reliability as well.

**www.adlinktech.com**

## SWIR cameras, lights, and controllers for imaging

Smart Vision Lights introduces three separate lines of short-wave infrared (SWIR) LED-based machine vision lights. These lights complement the recently introduced Sony IMX990 and

IMX991 Senswir line of cost-effective imaging sensors as well as the quantum-dot SWIR Vision Systems CQD sensor line.

Sony's IMX990 and IMX991 image sensors for industrial equipment are the first products to use the company's new Senswir technology, in which photodiodes form on an indium gallium arsenide (InGaAs) compound semiconductor layer connected to the silicon (Si) readout layer via Cu-Cu bonding – a design that enables high sensitivity over a broad range of wavelengths. The Senswir design yields a SWIR image sensor that is compact yet capable of delivering seamless image capture over wavelengths ranging from 0.4 µm to 1.7 µm. With individual sensor pricing starting below 1,000 US Dollar, chips like the Senswir line and the recently introduced CQD sensor are poised to reshape the machine vision industry through a new era of cost-effective multispectral sortation and inspection systems.

Today, Smart Vision Lights offers five different SWIR wavelengths – 1,050 nm, 1,200 nm, 1,300 nm, 1,450 nm, and 1,550 nm – in three different form factors: linear, brick, and proximity spotlights.

**www.smartvisionlights.com**

## Industrial vision software receives Profinet interface


Univision, the parameterizable standard software for two and three-dimensional image processing, has been given an update. The release 2.2 enables Smart Cameras and control units to be integrated into controls quickly and easily via a Profinet interface. New software modules and new functions for the visualization of results also make this update particularly valuable for users.

Thanks to the integrated interface in Smart Cameras and control units, the results of image and profile evaluations can now be transferred in real time via the established Industrial Ethernet standard. This makes seamless communication between the sensor, software and control easier.

Another feature of the univision update 2.2 is the new web-based visualization function. This enables the results to be displayed as overlays (e.g. measurement points or lines) directly in the image or height profile. A "good/bad" display of the overlays in the signal colors red and green is also available, showing the user whether the test points are OK (OK) or not OK (NOK). All measurement results can thus be shown quickly and flexibly via a browser-based display.

The update 2.2 is rounded off with the new FTP module for saving image, profile or text files on the uniVision device itself or on a FTP server in the network. This enables image data to be generated and exported for documentation purposes. The additional new "Count" module also enables good and bad parts to be counted to provide an overview of the current production process. "Both modules are included in all univision packages and in all hardware classes. This makes univision even more capable and comprehensive." The newly integrated Visionapp 360 plugin even enables combined height profiles from 2D/3D profile sensors to be evaluated and cross-sectional areas to be determined.

**www.wenglor.com**

## JAI introduces "Flex-Eye"

JAI has combined a configurable design process with its Fusion Series of high performance, prism-based multispectral cameras to make it possible for customers to specify a custom set of multispectral wavebands for their Fusion Series cameras. The innovative new approach is called Flex-Eye and it is designed to make multispectral imaging more effective by precisely tailoring the wavebands to the exact requirements of specific applications, including those in fluorescence-guided surgery, food inspection, intelligent farming, agricultural analysis (NDVI/NDRE), electronics inspection, biometrics, and many more.

JAI's standard Fusion Series cameras are prism-based multispectral area scan cameras equipped with two or three Sony Pregius CMOS sensors offering either 1.6 megapixels or 3.2 megapixels of resolution and a set of predefined wavebands – one that spans the entire visible spectrum (400–700 nm) and one or two additional wavebands located in the NIR region (700–1,000 nm). A dichroic prism divides the incoming light to the separate sensors while maintaining a common optical path. This affords simultaneous capture of all wavebands with high frame rates and perfect pixel-to-pixel alignment enabling the cameras to handle movement and fine details that might cause problems for other types of multispectral cameras.

**www.jai.com**


# The Barcode Ace

## A Smart Solution to Complex Code-Reading Situations

**While barcodes are becoming smaller and packed with more information, they are increasingly used in complex applications. Therefore, intelligent barcode readers need to master various challenges in the industrial fields.**

In 2019, vision solutions provider Hikrobot released the new smart code reader ID series. After successfully introducing the first ID series product, the ID6000, to the market, the company went on to launch the ID3000 and ID5000 successively. Today, the ID series products have been proven to be optimal choices for those who are seeking for reliable code-reading solutions in demanding tasks.

### Barcode Trends

Barcode is a carrier of information. It can contain the country of production, manufacturer, commodity name, book classification number, origin and destination of express, category, production date, etc. Consequently, barcodes are widely used in commodity circulation, library management, postal management, banking system and many other fields. Generally speaking, assigning a barcode that contains related information to every single product is a universal method to realize the track & trace and quality management in modern manufacturing industry.

It is a trend that barcodes are becoming smaller in size while richer in information storage, which requires higher processing capability of barcode readers. Besides, in certain industries, barcodes are directly marked onto objects, such as metal parts in automobile industry or PCBs in consumer electronics industry. In those occasions, a more robust code-reading performance is desired to avoid the influence generated by the reflection on the surface or the distortion due to irregular object shape.

### Barcode Reading Applications

ID series smart code readers are designed to meet diversified demands from diverse industry fields. Embedded with deep learning hard cores and self-developed high-performance algorithms, the ID series can easily deal with the barcodes in complex situations such as film coverage, poor printing quality, reflective surfaces, low-contrast backgrounds, etc. Particularly, the ID3000 and ID5000 series feature modularized field-interchangeable optics and lightings which are favored by industrial code-reading applications in mixed-model manufacturing lines.

### Logistics

In the logistics industry, it is necessary to record the information of each parcel in the process of inbound, outbound, sorting, distribution and so on. If these tasks were to be carried out by humans, it would be not only be a waste of time, manpower and financial resources, but they would also generate a large number of errors. The ID6000 series smart code readers are specifically designed for logistics scenarios. Unlike handheld barcode scanners which still require manpower to handle parcels, the ID6000 smart code readers can be mounted directly above or aside the conveyor belt and automatically scan parcels when they pass by. Featuring ultra large resolution (up to 5440*3648), the ID6000 is able to provide a large field of view and reduce deployment cost while maintaining a stable and robust code-reading performance.

**» The ID3000 and ID5000 series feature modularized field-interchangeable optics and lightings which are favored by industrial code-reading applications in mixed-model manufacturing lines.«**

### PCB Manufacturing

PCB manufacturing is the key process in the consumer electronics industry. In the PCB manufacturing industry, 2D codes are used to record production time, location, soldering temperature, flux density, batch number, test information, etc. As the information extent keeps increasing and the code sizes are shrinking, the requirements on code reading systems tend to become more rigorous. The ID series smart code reader is able to steadily locate and recognize tiny 2D codes with high accuracy thanks to its powerful deep-learning algorithms. Moreover, the optional integrated red light-source (ID3000/ID5000 provide an integrated light source) can effectively increase the contrast for PCB inspection.

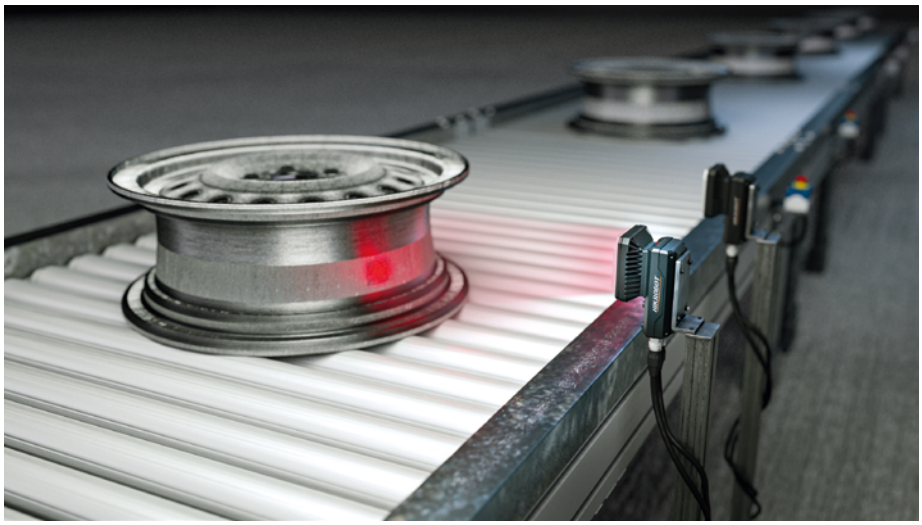
### Automotive

The modern automobile industry is paying more and more attention to the quality and safety of cars. The complete and accurate recording of the serial number, production batch, production date, and other information of various parts in the production and assembly is the key to guarantee both product quality and safety. Data matrix codes are often printed directly, by laser, onto key components such as engine blocks, connecting rods and clutches to realize traceability. However, the code contrast is usually poor, and the component surfaces are sometimes covered by oil. With the help of deep learning code-reading algorithms, the ID3000 and ID5000 can easily deal with stain, defect, low contrast, and other interference. At the same time, the 4-way independently controllable lights provide a more flexible approach to restrain the reflection on metal.

### Food & Packaging

In the food and packaging industry, the demand for decoding efficiency and recognition rates is still valid, but the core concern is different to some extent. Since the inspected object is on a relatively fixed position on the conveyor and the movement is very fast, people usually focus more on the processing speed and care less about the field of view or depth of focus. The ID3000 and ID5000, in this case, are the ideal options by virtue of their high frame rate and flexible modular design, which are a natural fit for mixed-model manufacturing lines. On top of that, ID5000 also supports mechanical auto-focus to further ease the setup and maintenance.

Requirements vary in different application scenarios. To choose an appropriate smart code reader based on real needs is the key to succeed in mastering modern code-reading challenges. The Hikrobot ID series is a reliable product that dares to face any challenge of the task. ■



**Smart barcode readers excel in the inspection of metal parts.**

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# Exceeding 5-Megapixel Lens Range

## Series of Lenses Developed for Use With 3.45µm Resolution 2/3" (IMX264) Cameras

**High-performance lenses are mainly required in the checking of high precision printed circuit board mounting, metal sheet surfaces for hairline cracks, intelligent transportation systems (ITS), 3D imaging, missing pixels on LCD monitors, and inspecting food and pharmaceuticals for shape, colour, and the presence of foreign objects on their surfaces. The new lenses are not only optimised for high resolution and high contrast, but also for use in harsh environments and durable industrial systems.**

Ricoh's range of exceeding 5-megapixel lenses have a φ33 mm compact design which is both robust and durable. Made of metal and glass they are provided with locking screws and are ideal for installation with high performance equipment enhancing production line working efficiency. They have been designed with extremely low optical distortion of < 0.1% (except 8 mm) and despite their small diameter, vignetting has been reduced to the minimum producing bright, high contrast images all the way to the edges.

### S-Rank Performance

These lenses use JIIA (Japan Industrial Imaging Association) high performance class/evaluation standards for high definition camera lenses and satisfy S-Rank (Standards by JIIA; Best Performance Class) criteria. According to the JIIA Technical Report (JIIA LER-007-2012) the recommended optical specifications of lenses for high resolution cameras with a small pixel size can be broken down into two rankings:

- S-Rank: High performance lenses; the specifications are available over the entire image area.
- A-Rank: Standard performance lenses; the specifications are available over a large amount of the image area.

As entire field 5-megapixel camera lenses, these lenses have virtually no image quality deterioration at the edges, and even at distances outside their optimum design criteria, they clear Ricoh's strict standards ensuring fine optical characteristics. We can confidently recommend these lenses for use as high-resolution machine vision lenses as they capture 147 lp/mm high resolution, low distortion images not just from the center to the periphery but over the entire image measurement field.

### Floating Focusing Mechanism Technology

Incorporating a floating focusing design the exceeding 5-megapixel range of lenses reduce aberrations from an infinite to close working distance and can be used at distance in intelligent transportation systems.

In a normal optical focusing mechanism, when you adjust the focus, the whole lens group moves together, so that the distances between each lens does not change. In a floating mechanism, there are two lens groups. When you adjust the focus, only the front group moves with the back group remaining fixed. This position of the front lens group is optimised in order to minimise changes in aberrations due to object distance. A floating mechanism is more complex and its design more difficult because a lot of design simulations are required. The benefit of a floating focusing mechanism design is higher resolution at shorter and longer working distances in comparison to a standard normal focusing mechanism.

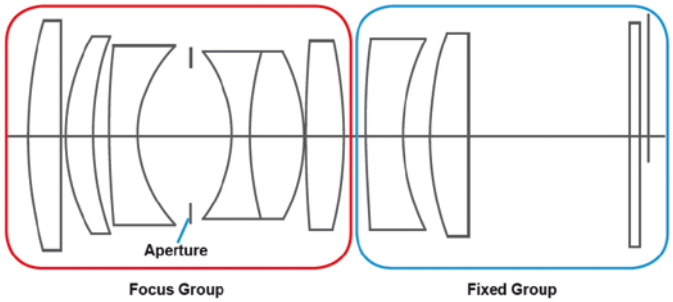
### The Design Philosophy

Even if you can ensure performance in desktop optical simulations, there is no point to such simulations if there is a huge difference in the characteristics of the actual equipment, so Ricoh utilises the following technology to provide the market with high performance lenses.

#### 1. Optical Simulation Technology Supported by Actual Results

To realise these lenses, the company shared information on their vital optical design technology with other products in the Ricoh Group and are always introducing new technology. They introduced their original algorithms for resolution and ghost analysis, and in post-design trials, confirmed that the characteristics on actual equipment were the same as in their simulations. These results were fed back into the simulations enabling technology improvement to ensure performance and to build on pre-existing technology.

All images: Ricoh




Example of a Ricoh product utilising a floating focusing mechanism

### 2. Tolerance Accumulating Technology with Due Attention to Variations During Mass Production

The manufacturer has created a parts tolerance accumulation system that is replete with their inherent knowledge of optical units, maintaining part processing precision and yield. They establish the required precision at part level in accordance with their original algorithms and verify them.

### 3. Precision Adjustment Technology During Mass Production

They have introduced adjustment technology to precision lens processing and assembly to their production process, concentrating the precision adjustment technology created by the Ricoh Group to produce lenses that are even more advanced.

## Applications

The main applications that require high performance lenses include the checking of high precision printed circuit board mounting, metal sheet surfaces for hairline cracks, intelligent transportation systems (ITS), 3D imaging, missing pixels on LCD monitors, and inspecting food and pharmaceuticals for shape, colour, and the presence of foreign objects on their surfaces.

FA lenses are frequently used in applications where multiple objects require inspection simultaneously or where a large range of objects needs to be inspected in detail. Vision systems in equipment that incorporate FA lenses can also be used as visual sensors, making them suitable for robot vision applications, which is why the company branded them "Exceeding 5MP". The entire range maintains high performance from the center of the image to its edges and from their minimum object distance to infinity and long working distances. These products will increase the degree of freedom customers have in incorporating them into the various applications they design.

In the same way as their 9 Megapixel lens range has minimal resolution loss on the periphery enabling their use with 1.1" format 12 Megapixel cameras, the peripheral resolution of Ricoh's exceeding 5-megapixel lens range surpass standard 5-megapixel class lenses. Therefore, the manufacturer envisions them being used with cameras exceeding 5MP resolution. The range currently consists of five lenses with 8, 12, 16, 25 and 35 mm focal lengths and will be joined by a 50 mm lens towards the end of 2020. ■

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| | | FL-CC0820-5MX | FL-CC1218-5MX | FL-CC1618-5MX | FL-CC2518-5MX | FL-CC3524-5MX |
|---|---|---|---|---|---|---|
| Resolution | | 5MP and Over | | | | |
| Format | | 2/3" | | | | |
| Focal Length | | 8mm | 12mm | 16mm | 25mm | 35mm |
| Maximum Aperture Ratio | | F:2.0 | F:1.8 | | | F:2.4 |
| Iris Range | | 2.0~16 | 1.8~16 | | | 2.4~16 |
| Mount | | C | | | | |
| Horizontal Angle Of View | 1/3" | 33.6° | 22.7° | 17.1° | 11.0° | 7.8° |
| | 1/2" | 44.0° | 30.0° | 22.7° | 14.6° | 10.4° |
| | 1/1.8" | 49.0° | 33.6° | 25.4° | 16.4° | 11.7° |
| | 2/3" | 58.5° | 40.5° | 30.9° | 20.0° | 14.3° |
| Minimum Object Distance | | 0.1m | | | | |
| Back Focal Length | | 13.0mm | 13.2mm | 13.4mm | 13.6mm | 14.3mm |
| Filter Size | | 30.5 P=0.5mm | | | | |
| Dimensions | | φ33 × 43mm | φ33 × 47mm | | φ33 × 50mm | φ33 × 65.5mm |
| Weight | | 78g | 85g | 80g | 68g | 100g |

Specifications of the Ricoh lenses


The FXO camera series from SVS-Vistek is based on the latest Sony sensors and provides a 10GigE interface and a C-mount lens connection.

# 10GigE Vision

## A New Era for Image Processing

**The Ethernet-based interface 10GigE Vision has the potential to lead the image processing industry into a new era. This new technology offers a number of innovative features for use in a wide variety of areas.**

The sales trend in the machine vision industry has known only one direction for many years, apart from the current, corona-related weakening: It is going up, with growth rates that are usually higher than those of the entire automation environment. The rapid development is not only taking place at the level of image sensors, but also with regard to the evaluation of images (keywords deep learning and artificial intelligence) and the transport of image data via more powerful interfaces. Numerous experts are currently expecting a lot from a new technology being launched: The 10GigE Vision interface is intended to give image processing an additional boost and pushes the limits of what is feasible.

The increasing complexity of automated product tests requires better images with higher resolution. As a result, cameras with resolutions of 12 and more megapixels are being used more and more in many image processing applications. The CMOS sensors used allow high bandwidths of currently up to 90 GigaBit/s and can reproduce very high image frequencies even at high resolutions. To forward the resulting enormous amounts of data from the camera to the PC, powerful interfaces with a high bandwidth are required.

The maximum speeds of image processing interfaces have increased steadily in recent years. According to the current state of the art, systems based on 1GigE Vision enable data transmission of around 120 MB/s, USB3 Vision achieves a maximum of around 360 MB/s and Camera Link systems can deliver up to around 850 MB of data per second. Image processing systems that are equipped with a super modern 4-channel CoaXPress-12 interface currently set the bar highest with net transfer speeds of up to around 5 GB/s.

**»The large selection of standardized components for field cabling speaks for the future success of the interface novice.«**

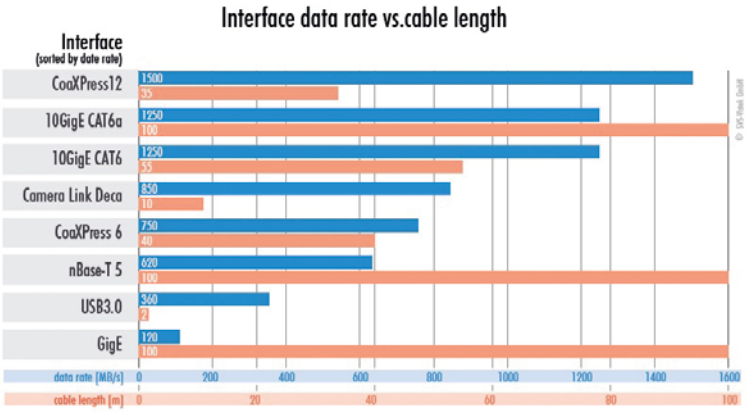
At the moment, the new 10GigE Vision interface will enable around 1,250 MB/s, which raises the question why manufacturers and users of industrial cameras are looking forward to this technology with such high expectations if it does not achieve the speed of CoaXPress. The main reason is: CoaXPress requires a special frame grabber which is fast – but also expensive. 10GigE components from the interface to the cables, however, are already standard technology with cost levels well below other options.

### Good Arguments for 10GigE Vision

For users, in addition to the data transmission speed, the maximum possible cable length is also a decisive criterion. This is where 10GigE Vision scores over other interfaces with a maximum data transmission length of up to 100 meters with CAT 6a cables: with USB3-Vision the limit is 2 meters, with Camera Link the end of the flagpole is reached at 10 meters, and CoaXPress reaches its limits at 35 meters. In addition, with 10GigE several cameras or sensors can share one cable due to the packet-oriented protocol and the possible connection via switches - a unique selling point of Ethernet-based interfaces.

10GigE Vision has a lot of advantages over other methods. The Ethernet protocol has proven itself in the industry for many years. In terms of topology as well as software, 10GigE Vision can be scaled transparently from existing 1GigE Vision applications and is already widespread in the server world. The necessary switches are available as inexpensive mass-produced goods. 10GigE is already day-to-day business in many IT areas. 10GigE adapters for PCs also impress with their price of less than 100 US dollars and have been standard on better equipped mainboards for a long time. Special and expensive frame grabbers for image acquisition are unnecessary. Network properties, advantages and disadvantages of the previous 1GigE interface also almost completely apply to 10GigE. And GigE is a well-accepted standard in industrial image processing.

The large selection of standardized components for field cabling also speaks for the future success of the interface novice. Industrial Ethernet cables with M12x8 connections




**With a maximum transmission speed of around 1250 MB/s, 10 GigE Vision ranks between Camera Link and CoaXPress.**

have been "10GigE-ready" for years, and on the I/O side, i.e. for the required control signals and also for LED lighting, the M12x12 standard is ideal for image processors to create robust connections with IP protection class and certification based on industry standards. The infrastructure already exists and has proven itself.

## New and Economical Technology

Camera data streams have special technical features. Currently, the configuration of a PC with a 10GigE network card and camera still requires some know-how in order to be able to maximize the theoretical maximum speed of a 10GigE camera. Current cameras with 10GigE such as the hr342XGE from SVS-Vistek with 31 MP or the hr25XGE with 25 MP deliver more than 1.1 GB/s of net image data rate, which is close to the theoretical maximum of the interface. Such a bandwidth naturally requires sufficient CPU capacity on the processing side, but opens up new possibilities, because this enormous bandwidth is available from the hardware inexpensively and in a scalable manner (i.e. almost without changing the software compared to 1GigE Vision) from the application side. For this reason, the first 10GigE systems are already being developed, because they offer such clear technical and economic advantages.

## Areas of Application for 10GigE Vision

Many experts see the factory floor as an essential area of application for 10GigE Vision, i.e. the domain of mechanical and plant engineering in many industries such as automotive or food production and wherever high transmission speeds and/or long cable distances are required. The direct consequences of faster image data transmission are that more time is available for the evaluation of the image data and thus more precise statements about the quality of the test object are possible or the throughput per test unit can simply be increased.

It essentially depends on the task at hand whether users will upgrade their existing systems from 1 to 10GigE Vision: For long-running systems without the need for more performance or additional image evaluations, replacing the interface will not bring any economic advantage. If, on the other hand, the faster image acquisition in existing systems allows more throughput or improved image evaluation by changing to 10GigE, the user benefits from a higher inspection quality or an increase in the production flow. A system upgrade by exchanging the PC and the recording unit may possibly make sense in these cases. This shows: 10GigE is an extremely economical high-speed interface.

SVS-Vistek's forecast is: 10GigE Vision will develop into one of the most important interface technologies in image processing within a few years. When designing new systems, the proportion of 10GigE vision systems will certainly increase significantly in the future. ■

All images: SVS-Vistek

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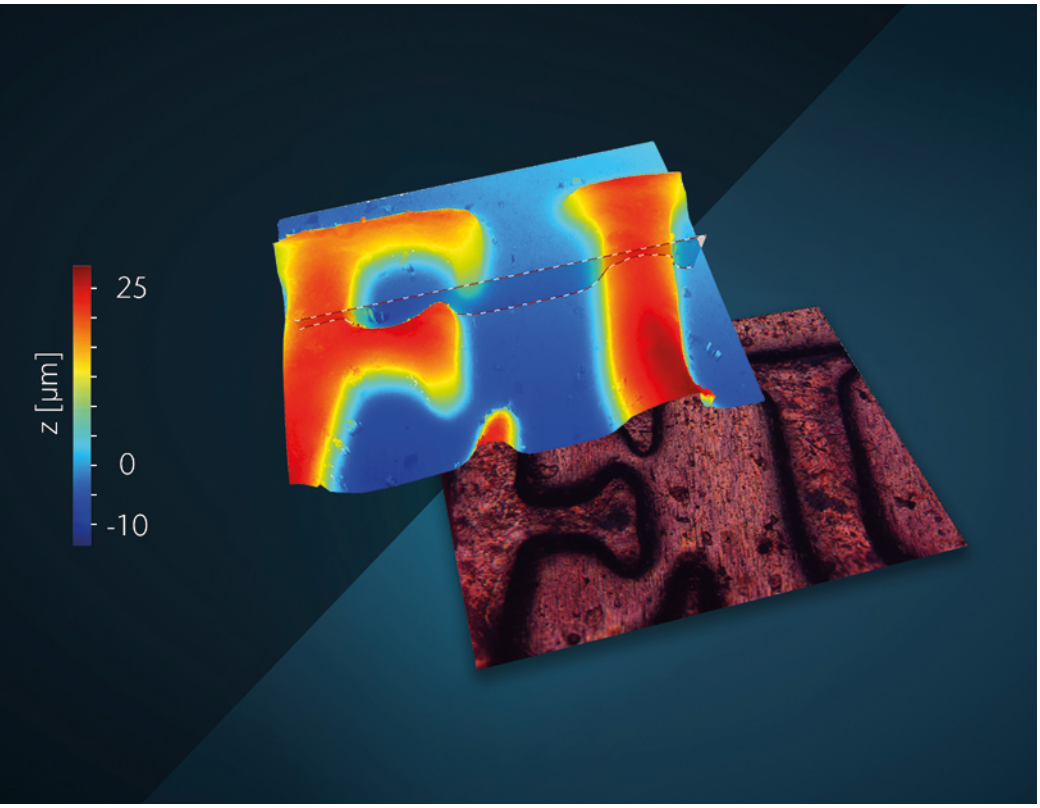


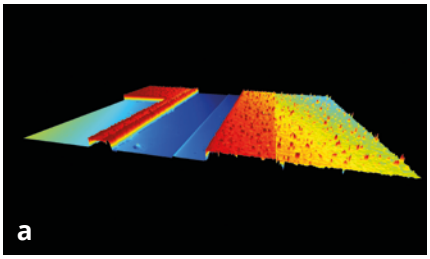


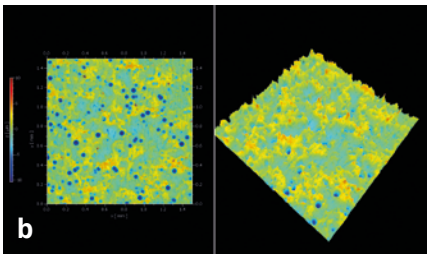


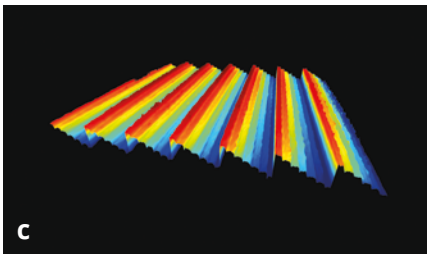


# Surface Topography Measurement

## High Lateral Resolution and Wide Measurement Range for Structures with Nanometer Dimensions in Industry, Research, and Laboratories

**When testing the surface quality of the finest structures, white-light interferometers are in their element, both in production and development, as well as in laboratories and research. This measurement principle works on almost all materials, operates without contact, providing surface profiles in 3D with height resolutions in the nanometer range. Today, large-area measurements are just as possible as detailed investigations with high lateral resolution, e.g. for surface characterization of wafers, optical components or in tribology.**

Modern white-light interferometers use the interference effects that occur when the light reflected from the object under investigation is superimposed with a reference signal. This measurement procedure is based on the principle of Michelson interferometry, where the optical configuration contains a light source with a coherence length in the µm range. The collimated (i.e. straightened or parallelized) light beam is split into a measurement beam and a reference beam using a beam splitter. The measurement beam strikes the object, while the reference beam strikes a mirror. Light reflected from both the mirror and the object coincide at the beam splitter and are focused onto a camera. If the optical path for an object point in the measurement arm matches the path in the reference arm, constructive interference occurs for all wavelengths in the spectrum of the light source. The camera pixel of the respective object point then has maximum intensity. For object points with a different optical path, the assigned camera pixel has a lower intensity. Instruments with a telecentric configuration therefore allow simultaneous and quick measurement of the topography of large surfaces in a single pass. If, however, high lateral resolution is required, microscope-based systems, in which the optical configuration (including the reference arm) are integrated into the lens, are more suitable.

### High Lateral Resolution Across the Entire Measurement Range

With the white-light interferometers for use in various fields of application from the TopMap series, Polytec has for several years been offering suitable measuring systems which have proven themselves in many applications. Typical applications for scanning interferometers are flatness measurements on sealing surfaces, the curvature of diaphragms, detection of warpage, or the detection of form deviations on pumps as well as high-pressure components, for example.

Recently, the demand for measurements of structural details, e.g. roughness, as well as

◀ Detailed measurements with high lateral resolution, e.g. to detect microstructures on wafer surfaces (a), to analyze droplet distribution in printing processes (b) or to determine surface roughness of optical components (c).

Microscope systems with high lateral resolution across the entire measurement range up to 100 mm

for motorized accessories such as encoded turret and positioning stages including tip/tilt stages, have increased significantly. For this reason, the TopMap series has now been extended to include further microscope-based models. The new models offer a significantly higher number of measurement points in the X and Y-direction and, thanks to special Continuous Scanning Technology, across the entire vertical measurement range of 100 mm instead of just a few micrometers. This means that even more detailed measurements are now possible, e.g. to detect microstructures on wafer surfaces, to analyze the microstructures in printing processes, or to determine the surface roughness of optical components. The color information from the object, which is supplied in addition to the height measurement, simplifies defect detection and improves reporting capabilities. If white-light interferometers are used in harsh production environments, the optional ECT (Environmental Compensation Technology) automatically compensates for environmental disturbances.

## Two Models, Many Possibilities

These two microscope systems in practice cover quite different user requirements. The table-top version TopMap Micro.View is designed as an entry-level model that can be used quickly and easily as a stand-alone solution anywhere, e.g. in smaller test laboratories or research institutes. The turret and X/Y positioning stage can be positioned manually, or a suitable motorized positioning stage is available upon request. Motorized positioning of the Z-axis is always possible.

Those requiring additional flexibility and performance are well advised to use the TopMap Micro.View+. This advanced version offers motorized X, Y and Z axes with a range of travel of 200 x 200 x 100 mm³ as well as a motorized turret and tip/tilt stage. Measurements can therefore be run automatically according to specific "recipes". In addition, there are variation possibilities in design. For example, samples with a height up to 370 mm can be measured and, if required, the sensor head can also be separately integrated directly into the production line. Thanks to the autofocus function and automatic focus tracker, the measurement system always has the object or sample in sight. The focus tracker works similarly to a face recognition function; the focus is automatically followed if the object position varies.

## Hardware and Software from a Single Source

Thanks to many export options, 3D measurement data from the white light interferometers can be processed using any suitable evaluation software. However, the TMS software, which has been specially developed for these Polytec topography measurement systems, is particularly easy and practical to use and offers numerous options for evaluating the measurement results quickly in accordance with ISO standards. "Measurement recipes" make routine tasks easier. Here, the settings for data acquisition (such as measurement position, illumination settings, camera parameters) can be defined and stored together with evaluation parameters e.g. post-processing steps, visualization or export options) for special measurement tasks. This turns complex surface analyses into simple one-click solutions. This saves time, especially in the production environment, and avoids operating errors; even non-experts can work with the measurement systems.

For those who are unsure which of the different white-light interferometers are best suited for a particular measuring task, feasibility studies combined with consulting and project support are available. In addition, potential users can confidently rely on the information given in the data sheets. Polytec is a member of the Fair Data Sheet initiative, which defines guidelines for uniform instrument and process specifications so that data sheets for optical surface metrology are transparent and, above all, comparable. ■

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All images: Polytec

# View from the Top

## Vision Sensors as Monitoring System Provide Various Advantages and Reduce Plant Cost

**The automotive manufacturer Opel in Rüsselsheim relies on innovative technology in production. At a welding robot various stamped and deep-drawn metal sheets are welded to form a supporting element of the bodywork. A 3D camera monitors the position and the fixing of the sheet metal parts.**

### The Sensor

Ifm's O3D302 vision sensor is a 3D camera with integrated image evaluation. The resolution of the PMD image sensor is 176 by 132 pixels. For each of the 23,232 pixels the sensor supplies a precise distance value – up to 25 times per second. In contrast to laser scanners, the Ifm 3D sensor has no moving parts. Therefore, it is especially robust, small and cost effective. Since the 3D image is evaluated in the sensor, external image evaluation is not needed. The distance between the clamp and the sensor is evaluated via definable positions in the camera image (called ROIs, region of interest). The integrated evaluation detects if the tension lever is "open" or "closed". The events are transferred to the controller using the integrated Ethernet interface via TCP/IP, Profinet IO or EtherNet/IP. The live camera image can also be provided. Using the Vision Assistant software, the user can easily set the sensor parameters, define ROIs or configure the output function, for example. This software is available both for Windows PCs and for iPads.

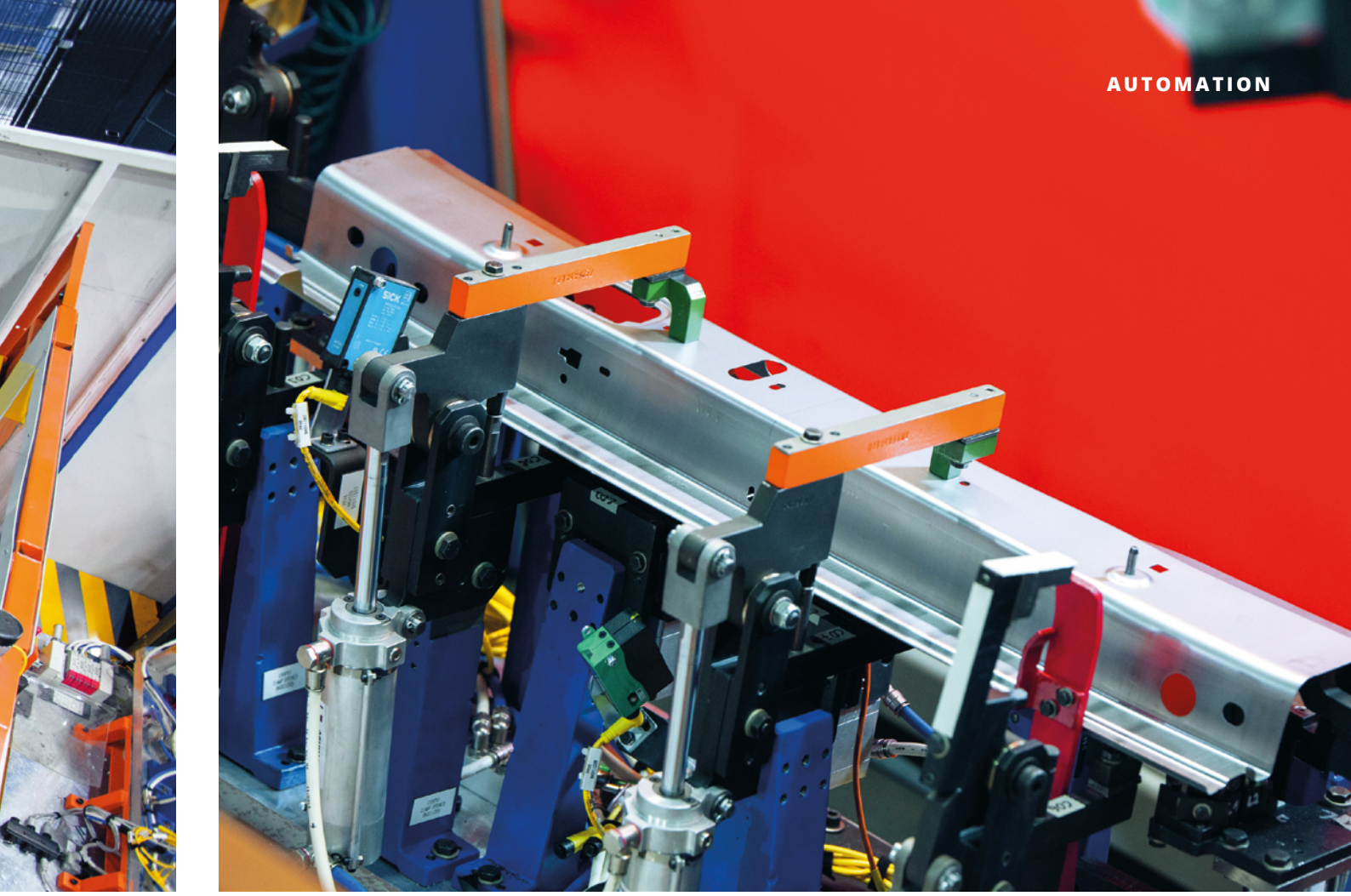
### Looking Down from the Top

Two of these sensors are installed above the welding system, one in the placement area (component placed), the other in the actual welding area. Both look down from the top to the sheet metal to be welded and their clamps in the installation equipment. The advantage of the O3D is that you only need one sensor and can then redefine ROIs in the software. We have aligned the ROIs to the end positions of the clamps and the workpieces and then we simply use the distance measurement for detection: 'Is a component present' or 'Has the clamp reached its end position?'

**The 3D sensor simultaneously monitors several positions.**

### Cost Savings

Instead of many sensors only one single 3D sensor simultaneously detects the position at several points in the equipment. Using the O3D vision sensor, approximately 80 %



Various stamped and deep-drawn metal sheets are welded to form a supporting element of the bodywork.

of the conventional sensors can be replaced in this plant.

There are even more saving potentials by reducing cabling, installation accessories and I/O points at the controller.

## Visualization

For transparency in the process, Opel have installed a monitor for visualization in the plant. Besides graphic process visualization, the O3D can also provide a live image.

Thanks to the live image, the advantage of the ifm sensor is that we have assigned end positions to the clamps and components, which are visualized in the image. The red-green color change symbolizes to the operator if a workpiece has been placed and if the clamp is open or closed. This does not mean any more programming work because the sensor parameters have to be set anyway, and the live image is provided by the sensor."

## Space Saving

Due to the fact that instead of several sensors, now only one sensor is needed for the detection of several positions and this sensor is installed high above the plant, there are advantages for the construction of the plant. Claus Moog: "The use of the O3D sensor provides us with completely new possibilities; for example, we have more construction space and more space for accessibility to welding tongues. Furthermore, we can eliminate the susceptibility to failure of conventional sensors. Since the sensor is installed high above the welding area, weld spatter cannot reach it which would damage it over time as is possible with conventional sensors installed close to the welding tongues."

## Prospects

The experience made in this pioneer plant at Opel is overall positive. This will influence future developments in plant construction.

The O3D vision sensor was introduced in close cooperation with the developers of the vision sensor. Fabian Gulla: "The cooperation with ifm is very good. We had several meetings directly with the developers. So we could gain insight into important findings such as 'how does the sensor work?', 'what do I have to note?', 'what size must my clamp be so that it can be reliably detected'?"

## Conclusion

Fewer sensors, simpler plant construction, no interference due to weld spatter – the vision sensor as a monitoring system provides numerous advantages and considerably reduces the plant cost. Other production plants can also be equipped with the vision sensor and thus optimized. ■

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All images: IFM

## Mobile measuring station with Cobot for automated inspection tasks

With the Scancobot, GOM presents a mobile measuring station with collaborating robot, motorized turntable and software. Combined with the compact and precise Atos Q sensor, the complete system is designed for automated 3D measurements. The Scancobot is particularly suitable for efficient quality control of small and medium-sized components made of plastic, metal or cast iron. The Atos Q with triple scan principle, blue light equalizer and precise calibration as a self-monitoring system with active temperature management is optionally equipped with five interchangeable lenses. With these, measuring fields from 100 x 70 $mm^2$ to 500 x 370 $mm^2$ can be realized. Components with a weight of up to 50 kg, a diameter and a height

of up to 500 mm can thus be inspected automatically. The mobile measuring system is equipped with the all-in-one evaluation software GOM Inspect Suite including virtual measuring room (VMR) and a kiosk interface. The software simultaneously handles measurement planning, digitizing and inspection. The VMR completely reproduces the real measuring environment and measuring sequence and executes it automatically. The system is also particularly space-saving: its dimensions are 975 mm x 755 mm at a working height of 1,000 mm.

**www.gom.com**

## 3D portable coordinate measurement machine

Faro announced the release of a affordable and accurate 3D portable coordinate measurement machine (CMM): The Faro Gage. Ideal for small and medium-sized businesses performing high-accuracy tasks, the Gage is the most intuitive, ergonomic, and versatile articulated portable FaroArm, enabling machine shops to perform their most demanding 3D inspections in record time.

The all-in-one-solution also reduces calibration costs and minimizes clutter, replacing traditional hand tools such as calipers, micrometers, and height gauges, while providing 20 percent more reach than the previous-generation Gage arm. Lightweight and portable but with the precision of a lab instrument and the ruggedness of a shop floor device, the Gage sets up in seconds, reduces inspection time, and delivers quality results with exceptional flexibility, resulting in increased speed and productivity.

As the United States and the world begin emerging from the COVID-19 pandemic, the value proposition for such a product could not be clearer. While global industry is presently suppressed, economists predict a robust recovery by Q3 and Q4. That means that many machine shops now operating at half speed will rapidly ramp up production. Demand will surge and products will require fast-tracked release.

The Faro Gage achieves this aim by improving efficiency and productivity like never before. That efficiency begins with set-up. A universal quick mount ensures compatibility with a variety of mounting options that allows it to be set it up anywhere, including on-machine. A simple 2-button design, 6-point articulation and built-in counterbalance deliver exceptional ease of use and fatigue-free operation. Its compact design makes the product lightweight and easy to transport. The Gage is compatible with FARO's full line of metrology software, including CAM2 Probing, the simple contact measurement solution. The result is an advanced metrology device that delivers unparalleled performance.

**www.faro.com**

## New inline barcode verifier

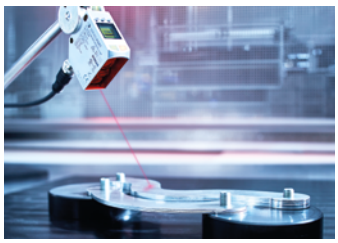
Cognex recently launched the new DataMan 475V inline barcode verifier. This high-speed system ensures contractual compliance with the International Organization for Standardization (ISO) regulations and provides the most reliable code verification and quality reports for 1D, 2D and DPM (Direct Part Mark) codes.

The DataMan 475V is equipped with precision optics, powerful lighting, robust evaluation algorithms and a high-resolution camera for capturing and classifying even the most difficult codes. The system uses a high-speed multi-core processor to ensure ISO compliance even at high production line speeds.

When code quality deteriorates, users now receive instant feedback to quickly identify print and process control problems, as well as the diagnostic tools needed to resolve them. Combined with extensive data transfer capabilities, the DataMan 475V ensures informative, repeatable results for a range of industries, including the automotive, medical, consumer goods, pharmaceutical and logistics industries.


**www.cognex.de**

## Laser proximity sensor with background suppression



"Detect all" is one of the operating modes of Sensopart's BGS sensor and is a function to be understood quite literally. The FT 55-RLHM can cope with any type of target object, whether it is brilliant metal, transparent or black against a black background. The sensor responds to all deviations from a given reference – such as a change in object distance, a different surface finish or even a deflected laser light beam. In this mode the sensor has no blind zone, i.e. objects are detected from 0 mm.

Even exceedingly small parts are reliably identified within the defined detection range, including objects at acute angles. The sensor can also integrate the energy remitted from the target object in the detection process. Thanks to its high level of detection efficiency, FT 55-RLHM can also be used to check the stack height of parts and identify multiple layers, for example when stacking cardboard packaging. Here the sensor automatically detects the presence of too many or too few layers.

A further highlight is the sensor's operating range of up to 1 m. The switching hysteresis is simultaneously minimal, so that even tiny objects are reliably detected from a long distancet.

**www.sensopart.de**

## AR workstation integrates technology based on edge computing

Image: Simon Toplak / Holo-Light

Holo-Light has expanded its augmented reality engineering space Ares, which was developed for engineers, with a pro version. The in-house remote rendering technology "Isar" (Interactive Streaming for Augmented Reality) is integrated in Ares Pro. The new server / cloud-based version breaks through all the limits of object size and complexity that were previously associated with AR content. In this way, high-polygon 3D content can be visualized in real size and, for the first time, edited interactively. In real time, with every detail and without the distortions that occur when reducing polygons.

Another important factor is the protection of highly confidential data. In contrast to other remote rendering solutions, the application runs where the customer specifies it: for example via specially controlled local servers or the cloud. Ares Pro is also more than a viewer. Users have the full functionality and interaction options of the Augmented Reality Engineering Space. You can visualize, manipulate and process data-intensive 3D CAD content in high quality as holograms in a real environment and work together in a virtual session. A clear unique selling point on the market for AR solutions.

One of the greatest challenges for industrial AR users is to visualize data-intensive 3D objects in real time and in high quality. Due to the limited computing power of AR glasses, CAD models often have to be prepared with polygon reduction. This in turn can restrict the quality of the 3D models so much that visualizations in AR are not very meaningful for the engineering process. Round surfaces become angular and details such as screws are completely lost.

With Ares Pro, the AR expert Holo-Light now offers a comprehensive AR engineering tool with an integrated remote rendering solution. The basic idea behind it is the outsourcing of demanding work processes such as application logic or content rendering. This means that the computing power does not have to come from the head-mounted display (HMD) itself, but can be provided by a powerful, secure local server or from the cloud. The entire Ares application is streamed from the server or the cloud, for example to the HoloLens 2 from Microsoft. Entire cars or larger production plants can be displayed with extremely low latency and therefore in real time. One example is the realistic, true-to-scale AR model of the International Space Station (ISS). The solution could process 80 million polygons at a speed of 40–60 frames per second. Autonomous AR data glasses can only work below approx. 1,000,000 polygons.

**www.holo-light.com**

## Code reader for miniature codes

With the Lector 61x, Sick is expanding its portfolio of image-based code readers. The compact device detects 1D, 2D and stacked codes for identification, inspection or content monitoring in production processes.

The trend towards batch size 1 drives development when it comes to automation of manufacturing processes. In order to ensure short throughput times in spite of individualized products as well as to remain competitive in production, Sick delivers the right sensor solutions like the new Lector 61x.

The smallest image-based code reader measures just 30 x 40 x 50 mm and supplements the Lector series for detecting 1D, 2D and stacked codes. In addition to the logistics and automotive industry, these are used for tracing components, especially in the sensitive and miniaturized electronics and solar industry for identification of electronic components, devices and printed circuit boards.

Thanks to the compact housing with conducted plug unit, it can be installed into production lines with limited space. The Lector 61x is characterized by very good read properties for very small codes, poor code quality and short reading distances. The code reader can even read codes which are not visible to the human eye. Using a clever decoder algorithm, its high-performance DPM decoder can read lasered or dot-peened codes perfectly – even in the case of low contrast levels, contamination, or poor code quality. The flexible lighting concept with eight LEDs and two colors can be controlled and enables reliable code identification, regardless of the surface or code color. The adjustable focus setting with distance LED and LED aiming device enables quick and easy commissioning.

**www.sick.de**

## Versatile light ambassadors

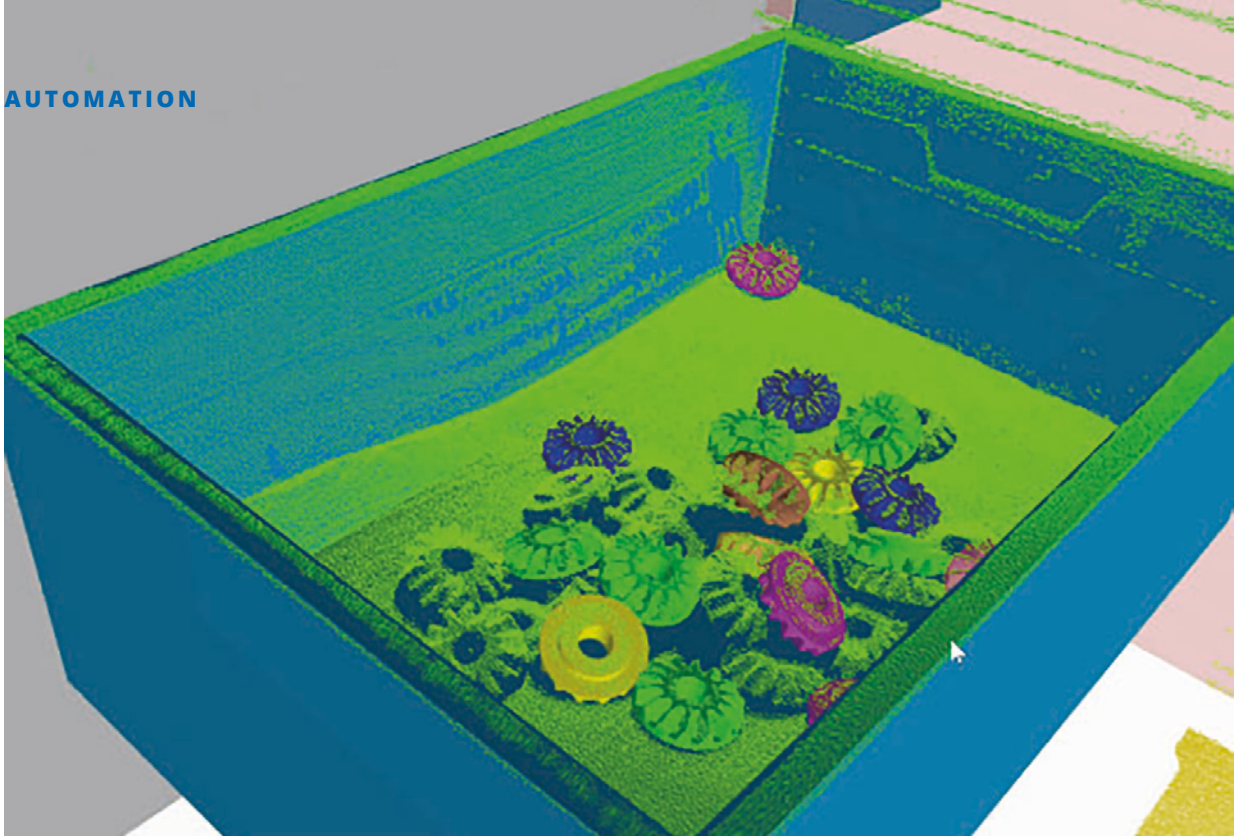
The LED signal light SBP-RGB with 360 ° visibility from di-soric represents a wide range of display applications in the industrial environment. The compact and robust light allows a task-oriented, freely selectable spectrum of color selection and signal representation. It is easy to parameterize and quickly operational via the integrated IO-Link interface. Via two trigger inputs and three color presets (red-green-yellow), the energy-saving signal light can be used immediately out-of-the-box and can also be operated without IO-Link.


With the LED signal lighting SBP-RGB in IP67 design, the specialist in sensor technology, image processing components and LED machine and signal lighting is expanding its existing signal and machine lighting portfolio. The individually configurable signal light is suitable for a variety of display, information and warning tasks in large parts of the mechanical engineering, automotive, pharmaceutical and automation industries. The signal colors and the mode of signaling (constant, flashing, flashing) and the degree of brightness can be freely parameterized. Powerful LEDs make the light messages visible from all viewing angles, even in poor lighting conditions or in a dusty environment.

The parameterization of the signal light is quick and easy via the integrated IO-Link interface. The stocking of different lights and color modules required with conventional signal lamps is no longer necessary – and with it the costs for the corresponding storage. If the display mode has to be changed, this can be done in a very short time via the IO-Link interface. Alternatively, the versatile signal light can also be operated without an IO-Link master port.

The new SBP-RGB LED signal light from di-soric is economical and compact: the maximum current consumption is 70 mA. The impact-resistant polycarbonate diffuser cap with a diameter of only 50 mm also enables use in applications where space is limited.

**www.di-soric.de**



# Bin Picking System

## Automation of Hot Forming and Laser Cutting Processes

**An Automotive Metal Components Supplier Improves Production with Sophisticated Bin Picking Software.**

A lot has already been written about problems that generally arise in bin picking solutions and applications. This article, in contrast, will present a case study describing a bin picking system for the automation of hot forming and laser cutting processes developed by Photoneo for a specific customer. The custom features, specially developed for this client, have been transformed into generally available ones that are currently deployed by a wide audience of users.

### Hot Forming and Laser Cutting System

In 2018, Photoneo accomplished one of the biggest installations of its bin picking systems. The whole project consisted of 11 bin picking cells, including 11 robots and 11 scanning devices. The systems are currently handling 18 types of objects. The entire deployment was delivered to one of the biggest automotive suppliers of metal components for car chassis, and Photoneo was asked to help automate its hot forming and laser cutting processes.

The procedure is as follows: After the hot forming process, raw parts are transferred to an input pallet of the bin picking system. The scanner scans the input pallet, localizes a part, and navigates the robot to a gripping position. The main goal of the entire manufacturing line is to precisely position the metal object into the laser cabin. The laser is then used to remove overpress as a side product of the hot forming. After this procedure, the robot takes the cut-off part out of the laser cabin and places the processed object into an output pallet. This process posed a number of challenges which the Photoneo team had to tackle.

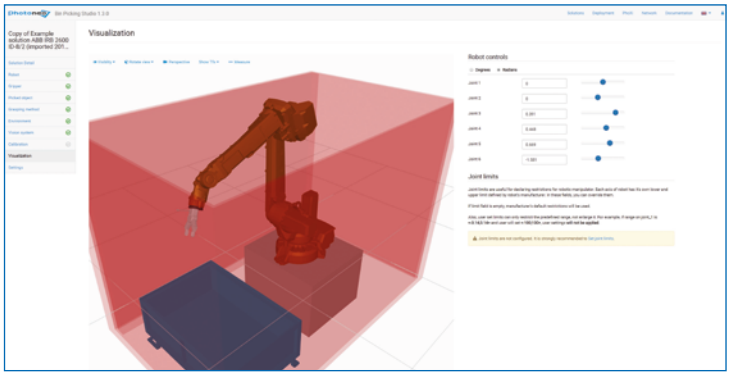
The entire integration of the vision system was based on a regular release of Photoneo's bin picking studio software. However, the process required several functionalities which had not been part of the release at that time. Since then, several updates have been released, the latest one being version 1.3.0 which contains all the above-mentioned required customizations. The new releases have been part of the company's strategy to make all the custom features available to a wider audience of experienced users.

### Additional Specialized Software Features

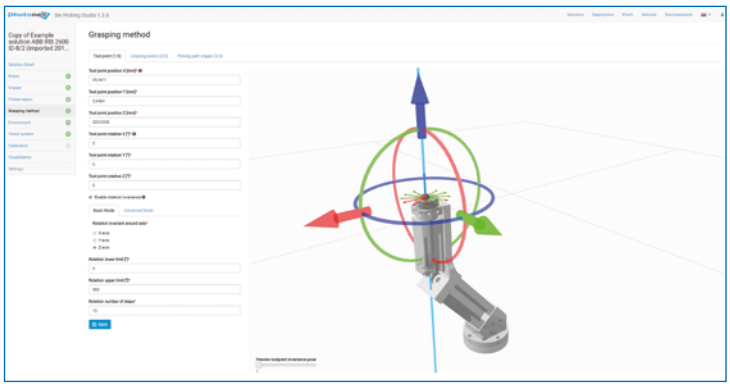
Among other features, the customizations included multiple vision systems and a so-called teaching gripping point option. The latter has been implemented as a result of difficulties related to the physical shape of the objects handled, which is rarely symmetrical. When combined with an imprecise stacking pattern, the possibilities of gripping poses are rather limited. This is why teaching of the gripping point is an extremely useful feature. The whole idea is based on utilizing the localization of the part firmly attached to the tool of the robotic manipulator. The system localizes the translation and rotation of the part and its relative position in the reference frame of the robot. The pose of the robot as well as the orientation of the tool point is then read from the robotic controller. This way, the gripping point on the object is recorded and stored for future use.

### Multiple Vision Systems

Most of the production lines contain two input boxes and two output boxes to optimize the production effectiveness. As soon as the first input box is empty, the robot moves on to the second box and continues in operation. In the meantime, an operator replaces the first, empty input pallet with new raw material. This process requires a scanning device above each of the two input pallets. However, in order to optimize the overall costs of the entire system, only one Phoxi XL scanner is used, which is mounted on linear axes. Two positions have been taught, one




**The robot takes the cut-off part out of the laser cabin and places the processed object into an output pallet.**




**Photoneo Bin Picking Studio Software – calculation of grasping points**


**Photoneo Bin Picking Studio Software – localization of objects**

for each input pallet. As soon as the first input pallet is processed, the robot commands the linear axes to move above the second input pallet. In order to make this feature available for the entire ecosystem of the bin picking studio users, the concept of vision systems was designed.

A vision system is defined by a particular scanner assigned to it and the calibration matrix transforming the scanner reference frame to the robot reference system. The vision system contains information about the localized object and the localization profile. One single scanner can be associated with several vision systems.

## Overall System Accuracy

Another challenge which needed to be addressed was the accuracy of the entire system. The line consists of various components whereby each of these is manufactured with a certain precision. The robot used for handling the materials in this application was configured for a reach of 3.2 m and a load of 150 kg. While it provides excellent performance in terms of repeatability, the level of accuracy is more relevant in a bin-picking application. This is typically 8 to 15 mm.

In addition to the limited robot accuracy, a similar constraint was posed by Photoneo's Phoxi 3D scanner XL. For this particular size and scanning volume, the point to point distance of the acquired point cloud is typically 2 mm and the calibration accuracy is 0,5 mm at the sweet spot.

The customer's requirement was to localize an object using a scanner mounted 4 meters above the input pallet with a precision below 4 mm. Initially, this goal seemed mathematically impossible, since the inaccuracy of the robot, scanner, linear axes, localization algorithm and other systems and tools involved added up to a significantly higher number. To cope with this challenge, the company needed to develop a unique calibration method. For this, they used a special calibration object which was firmly attached to the tool. A number of various calibration poses were acquired in the volume where the future gripping point would be present. This method proved that a precise scanner-robot calibration process can compensate for a certain degree of inaccuracy of the individual components.

It might come as a surprise that seasonality can also contribute to inaccuracy. Because we are talking about light industry manufacturing here, the environment in the hall is very unstable. For an object made of steel 6 meters long, a change of the ambient temperature from 18 to 40 °C would cause a dilatation offset of 0.21 mm. These seasonal changes can be mitigated by a regular scanner-robot recalibration.

## From Initial Challenges to New Features

The customer's application posed many challenges which needed to be tackled to successfully perform the required processes. Besides the above-mentioned, there were many others such as objects that were not rigid, the security of the proposed solution, adoption of the present tool changer and advanced control options from the robotic controller, such as for example a solution switch, used to quickly change a particular solution in the control system. None of these was easy to tackle, however, in the end they all led to the improvement of already existing and development of completely new features in Photoneo's products and solutions, which are now available to all users. ■

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# The Inspector Is on the Case

## More Flexible and Cost-Efficient Inspection Thanks to Fully Integrated Machine Vision

**With the goal of making inspection more flexible and efficient, while at the same time saving costs – Christ Packing Systems knew it would have to look beyond light curtains and conventional cameras for its new fully automated horizontal case packer, Caseteq. Instead, the packaging machine specialist turned a the fully integrated machine vision system.**

We offer product presence verification as a standard feature of our packaging machines. However, the type and scope of inspection this requires varies greatly depending on the customer, the product being packaged and the machine type," explains Timo Bochtler, head of electrical engineering at Christ Packing Systems. "In the past, we've used two different inspection systems for our horizontal and vertical case packers (top and side loaders): light curtains and conventional camera systems."

On a vertical case packer, bundle control can be implemented quite simply and cost-effectively using a light curtain: When a layer of products is pushed from the stacking area into the carton, the beams of the light curtain verify that no products are missing. The curtain is oriented with the beams perpendicular to the layer. If the layer is complete, the light beams will remain interrupted for a certain period of time as the layer is pushed through. If a product is missing and the beams are able to pass through, the change in beam interruption time causes an error message.

### Light Curtain: Simple but Inflexible

In addition to the low hardware costs, inspection with a light curtain offers a further advantage: When changing to a different format, the user can easily adapt the inspection process to the new conditions via the operator interface. All they have to do is set the start and end position (width) of the stack, as well as the number of required beams and the corresponding beam interruption time. However, a few test runs must first be completed before actual full-scale production can begin. These are needed to confirm whether the selected light beam configuration delivers reliable results.

If the layer contains rounded products, there will be gaps between them that allow the beams through – triggering an error message. To avoid that, the operator needs to disable the respective beams. "Sometimes you even have to disable two beams on top of each other to keep production running smoothly. But, whenever you do that, you also reduce the quality of the verification results," Bochtler knows from experience. "You also run the risk of operators forgetting to re-enable the beams when they change formats." Either way, light curtains have difficulties scanning layers of many small products and dealing with unexpected changes in requirements.

### Traditional Camera: Complex, Costly and Cumbersome

The horizontal case packing process does not allow for the use of a light curtain. So far, Christ has therefore used a camera mounted on the pick-and-place axis to verify packing completeness on its horizontal case packer. For image processing, Christ took the classical approach with a system made up of a camera, a lens, an image processing system (generally a PC), special software, and lighting elements as needed.

This solution is more complex and expensive than a light curtain, but provides additional flexibility, performance and reliability. It is also able to perform bundle checks and other more complex inspections, such as recognizing positions and patterns or reading codes and text.

The downside of the camera solution is the hefty price tag for all that hardware and software. Another factor that should not be underestimated is the added time and effort for the machine's software developers: traditionally, machine vision has been a stand-alone system, so the programmers would have to learn to work with proprietary software and additional interfaces. There are also strict limitations to how well the image processing software can be integrated into the machine application. On top of that, anyone who uses the image processing software requires special training. For the manufacturer, this usually means relying on third-party support.

Also, of great significance for those involved: The system needs to be calibrated in the field after installation and every time a piece of hardware is been replaced. "We're skilled mechanical engineers, but we are not camera specialists. We don't have the experience to know which situations will require lighting which won't," says Bochtler, focusing on another critical aspect of conventional camera solutions.

A machine builder who tries to cut costs by going without lighting runs the risk of having to retrofit lights later on. On the other hand, if they install lights that turn out not to be required, the investment would be wasted. In short, all the inspection solutions

Christ had tried in the past had come with unpredictable risks and hidden costs.

## The Solution: Integrated Machine Vision

When B&R first presented its integrated machine vision system to the Christ management team, they took notice immediately. The reason is fairly easy to see: Woven neatly into the company´s Automation Studio engineering software, the vision system is exceptionally approachable and manageable for the machine builder and its developers. From the comfort of their familiar automation environment, they have access to all the camera functions they need and easily integrate them into the machine application. No specialist image processing know-how is required, so introductory training is kept to a minimum.

The comprehensive portfolio offers the right combination for any set of requirements. It includes an array of different camera types with integrated lighting, a variety of resolutions and accessories such as external lighting. What truly sets the solution apart is the level of integration: all the components are connected by a common network and controlled by the same application. That's what makes it possible to synchronize the flash and shutter timing in the sub-microsecond range and make the most efficient utilization of the LED components.

## Scalable and Easy to Use

In circumstances that require just one specific image processing function, such as reading a QR code or position detection, the Smart Sensor version of B&R's camera is the right choice. Unlike many other devices in its class, there is no need to install extra camera hardware for each function that is required. Instead, the user simply configures the desired Smart Sensor function as needed in the Automation Studio engineering environment.


**Woven neatly into the B&R Automation Studio engineering software, the vision system is exceptionally approachable and manageable for the machine builder and its developers.**

All images: B&R


**The Caseteq case packer from Christ is a fully automatic horizontal system for erecting, packing and closing pre-glued shipping cases. Cameras from B&R will now be performing various inspection tasks.**

In cases that call for multiple functions, it's easy to upgrade to a more powerful Smart Camera. Any application software, parameters and models that have already been developed can continue to be used. The camera and lens come factory calibrated, so there's no need to repeat this step when commissioning the vision product. Installation could hardly be easier, because the camera gets all the settings automatically from the controller.

## Changeover at the Push of a Button

The tightly integrated solution has advantages for the user as well. All the parameters, including the focus setting, can be saved as recipes and loaded at the push of a button to accommodate a new case format. "Even if the data for a product or case format is not yet available, that's no problem. You just need to teach it a new product and enter how the products are arranged in the layer. The system handles the rest. That's one of my favorite parts," admits Bochtler.

Implementing rapid product changeover is even easier when the machine controller is also from the manufacturer, Christ was happy to learn. The system configuration and recipe management system can then be integrated directly into the HMI application. The familiar tools of the Automation Studio environment can be used for diagnostics. B&R's mapp Vision software component gives the programmers access to the Halcon machine vision library from MVTec. This library is full of field-proven, ready-to-use algorithms for position detection, completeness verification, quality assessment, measurement and identification. "They make it easy for automation specialists like us to implement machine vision solutions on our own after only a brief introduction," says Bochtler happily.

## New Inspection Solutions

Because of the advantages offered by the vision system, Christ decided to introduce its first fully automated horizontal case packer, with layer completeness verification performed using the new machine vision solution. The company plans to add new inspection tasks based on the system in the near future with the ultimate goal of converting all of its secondary packaging machines to the new technology.

"The vision package has everything we need. With the scalable solution, we're able to replace the separate control systems we used to need with a single, fully integrated solution for machine vision," explains Bochtler. "On top of being more economical, it adds valuable flexibility and reliability to the inspection process. At the same time, it reduces the risk of unpleasant surprises for us and our customers."

The Caseteq machine from Christ is more flexible, manageable and user friendly thanks to integrated machine vision from B&R. The system is more flexible than a light curtain and considerably more manageable and user friendly than a conventional camera system of comparable performance. ■

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Image: Teledyne Dalsa

# Imaging Inside Out: SWIR for Apples

## Changing Markets Drive New Investment in a Broader Spectrum of Machine Vision for Food Production

**The food industry is changing. While it is still too early to measure the true impacts of COVID-19 on global trade and consumption, many other factors are driving changes to food production, particularly climate change and population growth. After all, it is vision technology that supports miscellaneous improvements: for example, it helps to deliver better apples.**

High-value, specialized crops will be facing a great number of hurdles. Fruits and organic produce are grown by smaller farms and require more labor. According to the UN and IMF, measures to prevent Covid outbreaks will disproportionately affect these farms and potentially create price spikes that hit restaurants and consumers further down the supply chain. With higher costs across the board, there's already evidence of increasing fruit prices more than offsetting lower vegetable production.

A great example is apples, one of the most economically and culturally significant fruits in the world today, grown in every temperate zone around the world. They're also a high-value fruit that requires large crews for planting and pruning to ensure healthy trees and large harvests. Apples are a big business, with major players spread around the world.

Pardon the pun, but apples are also a growing business! Even during the pandemic, world production for 2019/20 is estimated to rise nearly 7 % to 75.8 million metric tons. China has rebounded from the frosts of 2018/2019 this year, growing production by 24 %, making it again the top apple exporter, and offsetting lower production in the European Union due to a combination of frost, drought, heat, and hail. U.S. production is estimated to have increased more than 300,000 tons to 4.8 million on rebounding output in top grower Washington state, resulting from favorable summer weather. Higher quality supply – and more of it – is expected to further boost exports to key markets.

Over the last several years, demands on the industry have evolved toward better quality, improved food safety and traceability. Higher demands for the treatment of labor, lower energy and water consumption, and safer agrichemicals have also steadily hiked productions costs. This has put significant pressure on growers, processors and retailers to adapt their supply chains. Recent developments in precision agriculture, molecular biology, phenomics, crop modelling and post-harvest physiology should increase yields and quality and reduce costs for temperate fruit production around the world.

### Delivering a Better Apple with Vision

If apples are going to be more vulnerable, scarce, and expensive, how can machine vision help?

People, as always, are inconsistent both individually and internally, and from day-to-day. Traditional inspection – humans manually cutting open and examining produce – is destructive, laborious, time-consuming, costly, and subjective. In contrast, imaging systems allow for high-speed, non-destructive quality inspection and grading. Visible, multispectral, and infrared imaging technology is already being deployed to varying degrees across fruit and vegetable grading

systems. Still, automatic quality and grading inspection is challenging which slows its adoption in robotic fruit and vegetable grading systems.

The challenges are multifold:

- Physical and biological variability (there are thousands of varieties of apple in the U.S alone);
- surface detection on uneven, rounded objects that vary significantly in size and shape;
- discrimination between defects and natural features;
- the reliability of the algorithms to date;
- the conflict between speed and accuracy in any optical detection system.

## What You're Looking for: Defining Quality

Looking at these challenges, it turns out that "quality" is difficult to define. It's not one single well-defined attribute, but instead many characteristics that define a quality fruit. Research has shown that among relatively similar cultures, even when the qualities are relatively consistent, the way that quality is recognized varies significantly. When more diverse groups are asked, culture consensus on 'quality' falls apart very quickly. These kinds of cultural differences are found all across research but force us to look at specific and more easily quantifiable aspects of a given apple.

That's only slightly less difficult. We've bred apples to look good to us. More than that, visible light tends to stop at the skin of the fruit, the pigments and chlorophyll and other bands of light can be scattered by the underlying structured tissues. By moving to NIR and SWIR, you can see water density and distribution more clearly inside the apple. This indicates key physical attributes that will help predict the measurable 'quality' of the apple, texture, water binding capacity, and specific gravity.

Abnormalities in texture and density can indicate bruising, which is particularly important for quality inspection systems. "Bruising" is damage to fruit tissue from external forces, compressing, cutting, or abrading the skin and flesh of the apple. This causes physical changes in the texture and chemical composition on the fruit, with immediate and long-term effects on color, smell, taste, and longevity of the product.

The susceptibility of apples to mechanical damage depends on many factors, including soil cultivation, nutrition, and weather conditions in the field during fruit growth, all of which have become more complex and extreme over the last few decades. Harvesting and transportation themselves can introduce bruising to the product and sticks and other debris in the production line can be equally damaging.

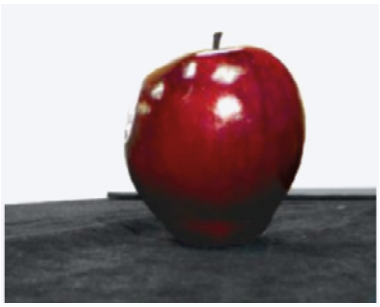

Image: Edmund Optics

**Visible imaging of red apple. Notice the apple looks perfectly red with visible imaging. Defects are not easily discernable.**

Image: Edmund Optics

**SWIR imaging of red apple. Bruising is clearly evident on the apple with SWIR imaging. It is easy to inspect any defects on the skin.**

With optical sorting, bruised product can be caught and removed. In fact, with more efficient sorting there is less likelihood of waste – apples can instead be sorted by their suitability for other products, like jams, preserves, and frozen mixes. Even though bruising is the top reason for rejecting fruit in sorting lines, automatic sorting systems still often lack precision in detecting bruises, driving companies to fall back on human/manual sorting methods.

## Infrared Imaging for Shelf Life

So how do we achieve higher precision?

We've seen how short-wave infrared imaging can help enable precision farming of crops in the field.

But once a crop is harvested, the need changes. A primary challenge to the plant food industry is the almost universal fact that the shelf life of plant foods is normally short. Generally, a shelf life of about seven days is required for domestic consumption and 7–15 days for overseas consumption. Through postharvest processing, storage, and transportation, the physiological qualities of harvested foods continue to change.

In 2007, researchers were able to use NIR/SWIR measurements to distinguish between apple varieties and between storage type and storage duration. Later, researchers used IR spectroscopy to examine the eating and sensory quality of apples (or what humans refer to as taste and texture) after 6 months of air or controlled-atmosphere storage. However, both these studies were not predictive; they only examined the apples after storage. It took larger improvements in infrared imaging technologies to take the next step.

For industrial evaluation that can inform production decisions, determining fruit quality needs to go beyond the immediately visible identifiers that consumers would rely on in the store, such as shape, size, color, texture and defects. Fruit producers need to look at the non-visible features that indicate future quality and longevity: sugar content, firmness, soluble solids content, and nutritional content. To do so, researchers created a system that incorporated imaging of reflected radiation across the visible, SWIR, and MWIR imaging ranges; 400 to 5,000 nm. It turned out that the whole spectrum is useful for detecting bruises. The deeper into the infrared range the imaging stretched, the deeper into the tissue of the apple the researchers could evaluate.

Clearly, a more comprehensive approach was needed to power production decisions. Researchers then moved to hyperspectral image analysis that included both NIR and SWIR wavebands, giving different 'depths' in the target image, the apple. Adding MWIR imaging proved useful for more extensive bruise recognition.

This was a lot of data to use simultaneously, particularly because the target object was not 2D, but 3D. Even better results were obtained by the use of Minimum Noise Fraction transform (MNF) rotation to determine the inherent dimensionality of the image data, to segregate noise in the data, and to reduce the computational requirements for subsequent processing MNF transformation whose components could be preferable for image segmentation purposes.

The analysis of the total scores for individual ranges (VNIR, SWIR or MWIR) indicated lower prediction values than in cases where these ranges were included jointly into models. The created models of supervised classification based on VNIR, SWIR and MWIR ranges indicate that best prediction efficiency for distinguishing bruised and sound tissues as well as bruises of various depths is obtained for models incorporating these three ranges together. This suggests that it would be reasonable to consider including MWIR range into sorting systems. ■

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