Special Issue
Vision 2021

VISION

SPECIAL TOPIC

Cameras

COVER STORY

Miniaturized Infrared Spectroscopy: Small but Powerful

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Partner of   VISION   AUTOMATICA   Control   emva   VDMA   spectronet.

It's Been a While...

...since we last had the opportunity to personally experience the latest products, technologies, and trend themes in machine vision in one central place. Finally, Vision fair will open its doors to the public again, with about 250 exhibitors presenting their solutions for embedded vision, hyperspectral imaging, and deep learning in Stuttgart from 5th to 7th October 2021.

The companies in the industry have been working hard on new products and solutions, and now they are more than ready to present them. This issue of inspect International already offers you a foretaste of the trade show as many of the companies mentioned will be there. Our topics include how robots complete humans and enhance their work, the use of 3D sensors in food branding application, how industrial cameras filmed the Mars landing of Nasa's Perseverance Rover, and a specially designed sCMOS camera that was used to develop an all-in-one microscope.

Sometimes it's the small things that make a huge difference. So does Hamamatsu's FTIR engine C15511-01, a compact Fourier transform infrared spectroscopic module with high sensitivity to near infrared light in the range of 1.1 µm to 2.5 µm. A Michelson optical interferometer and control circuit are integrated into a palm-sized housing. More details about this new solution can be found in our cover story: Small but Powerful – Interferometry in the Palm of Your Hand.

Powerful is also characteristic for the machine vision industry. There are positive times ahead: According to Grand View Research, the global machine vision market size is expected to expand at a compound annual growth rate (CAGR) of 6.9 percent from 2021 to 2028. The increasing demand for quality inspection and automation in different industrial verticals is likely to drive the market for machine vision. Additionally, the need for vision-guided robotic systems across the automotive, food and beverage, pharmaceutical and chemical, and packaging segments is expected to fuel the market growth.

Let's all keep on track and head back to a new normal. Enjoy reading our latest issue and see you soon,
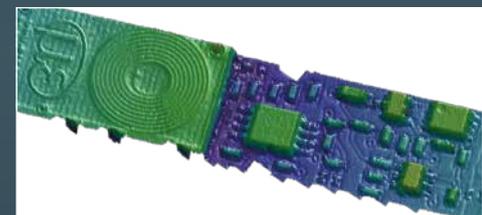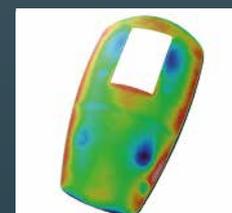
Yours,
Sonja Schleif

> ❮❮
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> **The increasing demand for quality inspection and automation in different industrial verticals is likely to drive the market for machine vision.»**

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SPECIAL TOPIC
Cameras

COVER STORY
Miniaturized Infrared Spectroscopy,
Small but Powerful

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Welcome to the knowledge age.
Wiley builds on its 200-year heritage
by partnering with universities,
businesses, research institutions,
societies and individuals to develop
digital content, learning, assessment
and certification tools. Wiley
continues to share and deliver the
answers to the world's challenges
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IDS: Above-average sales growth in the first half of the year

IDS exceeded industry expectations in the first half of 2021. Instead of the 7 percent increase in sales forecast by the VDMA for the image processing industry, the company has so far more than doubled its growth.

The camera manufacturer from Obersulm expects consistently high growth until the end of 2021 . The positive order situation and the strong development of the international business give every reason to do so, despite the generally difficult procurement situation. The increase in sales compared to the same period of the previous year 2020 was particularly strong in North America.

de.ids-imaging.com

Image: : IDS

Basler with record results in the first half of 2021

The camera manufacturer Basler has the strongest half-year in the company's history in terms of sales, profit and incoming orders. Compared to the same period in the previous year, sales rose by 30 percent and profits by over 60 percent. Compared to the first half of 2020, sales rose by 30 percent to EUR 115.2 million. Earnings before taxes rose by 63 percent year-on-year to EUR 20.8 million. Incoming orders rose by 65 percent to EUR 152.4 million. In the second quarter, incoming orders doubled compared to the previous year.

Basler thus again outperformed the industry in the first half of the year: As of the end of June 2021, the German Engineering Federation (VDMA) reported a 17 percent increase in sales for the German manufacturers of machine vision components for the year 2021. According to VDMA, incoming orders in the industry rose by 29 percent in the same period. As a result, Basler increased its market share considerably.

www.baslerweb.com

Image: Balluff

Groundbreaking ceremony on the Balluff company premises in Neuhausen, Germany. with representatives from Balluff and the community as well as those responsible for building.

Balluff: Groundbreaking ceremony for the expansion of the headquarters

Balluff is building another office and administration building at its headquarters in Neuhausen ad F., which will accommodate 530 employees. I n summer 2023 will be ready for the building.

The planned new building on the existing company premises between Zabergäu and Schurwaldstrasse offers office workplaces for more than 530 people as well as a company restaurant with more than 280 seats. If everything goes according to plan, the shell will be ready by July 2022. The building should be finished and ready for occupancy the following summer. With an investment volume of almost 60 million euros, the construction project for Balluff is one of the largest single investments in the company's history.

www.balluff.com

Image: Adlink

Adlink joins the O-Ran Alliance

Adlink is the O-Ran Alliance as a community member when entered . The aim is to be able to offer the Radio Access Network (RAN) industry intelligent, open, virtualized and fully interoperable cellular networks. The company can use its competencies in the development of Open Telcom IT Infrastructure (OTII) -compliant, standards-based 5G MEC edge servers for use in 5G Open RAN, 5G small cell solutions and private 5G networks with a global community of cellular network operators and academic and scientific institutions.

www.adlinktech.com

Former Quality Thin Films continues manufacturing as Edmund Optics Florida

The laser optics manufacturer Quality Thin Films, USA, which was acquired at the end of 2020, has been renamed Edmund Optics Florida. Under this company name, the company now produces short pulse optics with low group delay dispersion (GDD) and optics with high laser-induced damage threshold (LIDT).

With the takeover by Edmund Optics, Quality Thin Films (QTF), as a manufacturer of laser optics, is able to develop and coat optics with a low GDD. In addition, Edmund Optics now has the metrology needed to verify specifications.

www.edmundoptics.com

IFM invests in a new logistics center at the Tettnang location

Ifm is building a new logistics center in Tettnang with an investment of 12 million euros. It will go into operation in spring 2023, and the symbolic groundbreaking ceremony took place at the beginning of August . D as company creates 130 new office workplaces and new storage capacity to respond to the increased production volumes. The new logistics center will provide space for 4,400 pallet spaces that will be held in automated mobile shelving. This modern logistics concept offers high access speeds and makes optimal use of the available space.

www.ifm.com

Image: IFM

ON Semiconductor changes brand name to Onsemi

ON Semiconductor has a new brand name: Onsemi . With this, the supplier of power supplies and sensors wants to underline its further focus on the automotive and industrial market.

The industrial and automotive markets are now responsible for two thirds of global greenhouse gas emissions. According to Onsemi , energy and sensor technologies should help achieve a net-zero economy. Because climate change not only endangers the environment, but also offers opportunities for innovative business solutions, the group is certain. In addition, Onsemi is committed to leveraging its research and design expertise and adapting its own operations to achieve net zero emissions by 2040.

www.onsemi.com

White paper published on the energy management of AI systems

AI systems (AI = Artificial Intelligence) can increase efficiency, increase resilience and optimize security of supply in energy management, in distribution networks, for energy producers and end consumers. But how can AI, as a technology that is still very new for the energy sector, be integrated into an established energy ecosystem with its proven system approaches? The new KI Energy whitepaper from the VDE-sponsored standardization organization DKE provides answers to this question. The DKE brought together standardization and AI experts to create the whitepaper. They identified and classified over 300 standards that could be relevant for AI solutions in the energy sector.

The "KI Energy" whitepaper is available free of charge on the website .

www.vde.com

MVTec strengthens Halcon's product management team

Image: MVTec

With immediate effect, Susanne Kretzschmar is strengthening the strategic market development of the Halcon image processing software as Commercial Product Manager at MVTec. In her role as Commercial Product Manager, Susanne Kretzschmar is responsible for developing new license models and evaluating market trends in order to further develop Halcon's global product strategy.

Before joining MVTec, Kretzschmar headed product management, marketing and business development for a company in the chemical industry for three and a half years. Before that, she worked for several years in various marketing functions in international companies.

www.mvtec.com

Messe Stuttgart with halved sales in the corona year 2020

Landesmesse Stuttgart calls the balance sheet for the 2020 financial year the "worst result in the company's history". The restrictions of the corona pandemic led to sales being more than halved and a huge drop in earnings. Similar numbers are also expected for 2021. But the organizer of the vision is optimistic that the physical trade fair can at least start again from September.

Since spring 2020, the group has had to postpone or cancel 185 trade fairs and events worldwide. For the first time in its history, the company had to apply for short-time work for its employees. However, no redundancies were issued for operational reasons.

As of now, the physical trade fairs should continue as early as September. There are over 20 events on the agenda by the end of the year. These include Vision 2021, which will take place from October 5th to 7th, 2021.

www.messe-stuttgart.de
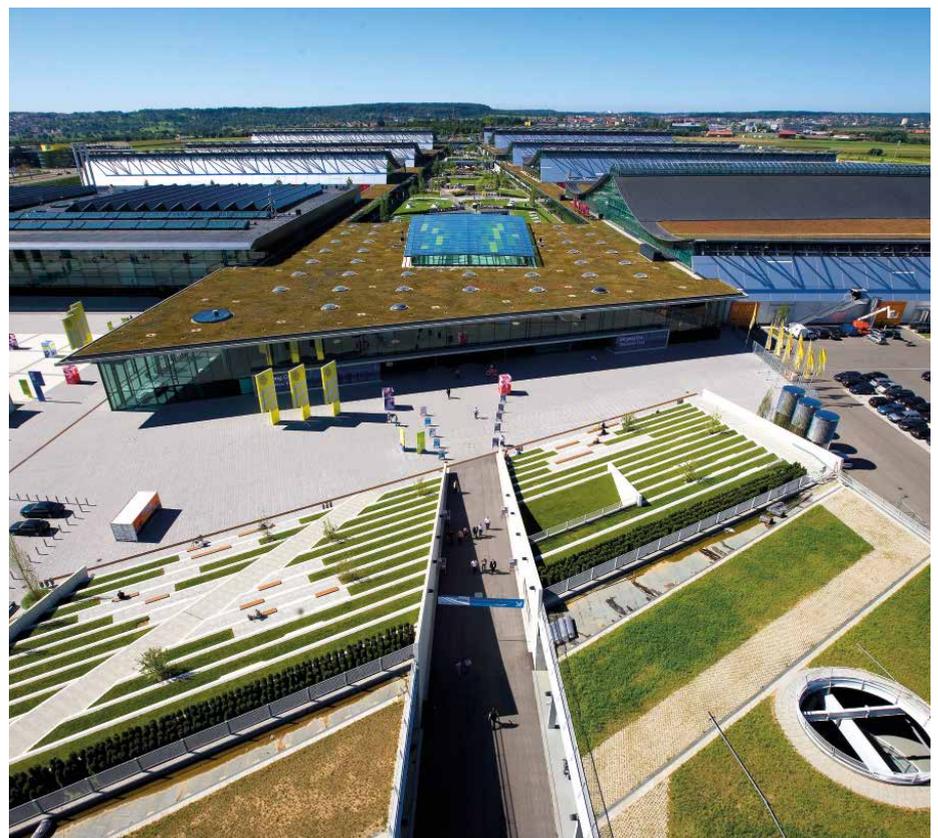
Image: Messe Stuttgart

The Ernst Abbe high-rise in Jena, Jenoptik's headquarters

Jenoptik: High growth in the second quarter 2021

Jenoptik achieved a sales increase of 29.6 percent in the 2nd quarter of 2021 compared to the previous year. Half-year sales increased by 18.3 percent to 389 million euros. Based on these figures, the optics group is increasing its targets for the full year 2021: sales are expected to rise to 880 to 900 million euros and the EBITDA margin to 19 to 19.5 percent.

Jenoptik achieved sales of 389.3 million euros in the first half of 2021, 18.3 percent higher than in the previous year. In the second quarter, the key figure increased by 29.6 percent compared to the previous year.

High organic growth and the contribution from Trioptics led to a significant increase in sales in the Light & Optics division in the first half of 2021. While the Light & Production division benefited from rising demand from the automotive industry and business at Vincorion also picked up slightly, sales at Light & Safety were below the previous year. Trioptics in particular contributed to the significant increase in sales in the Asia / Pacific region. The share of foreign sales remained unchanged at 74.2 percent.

www.jenoptik.com
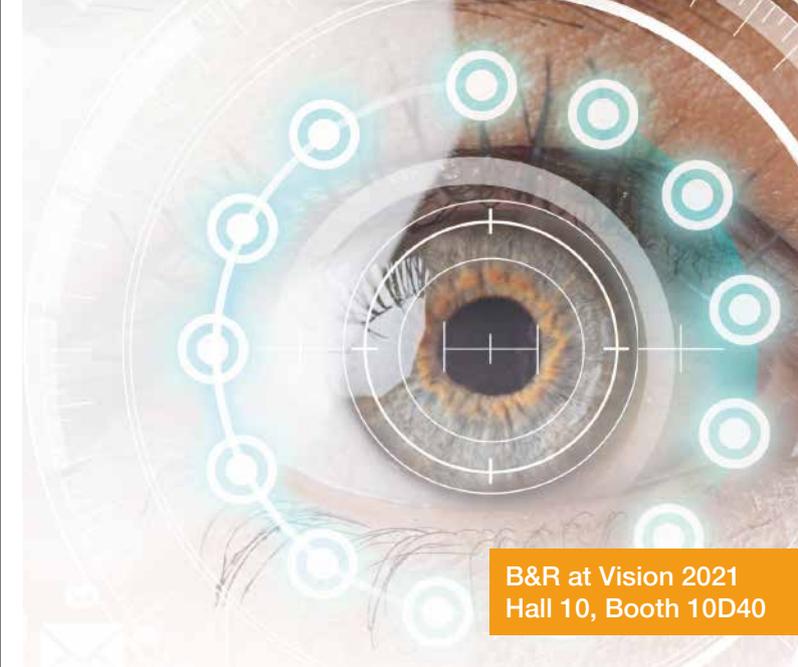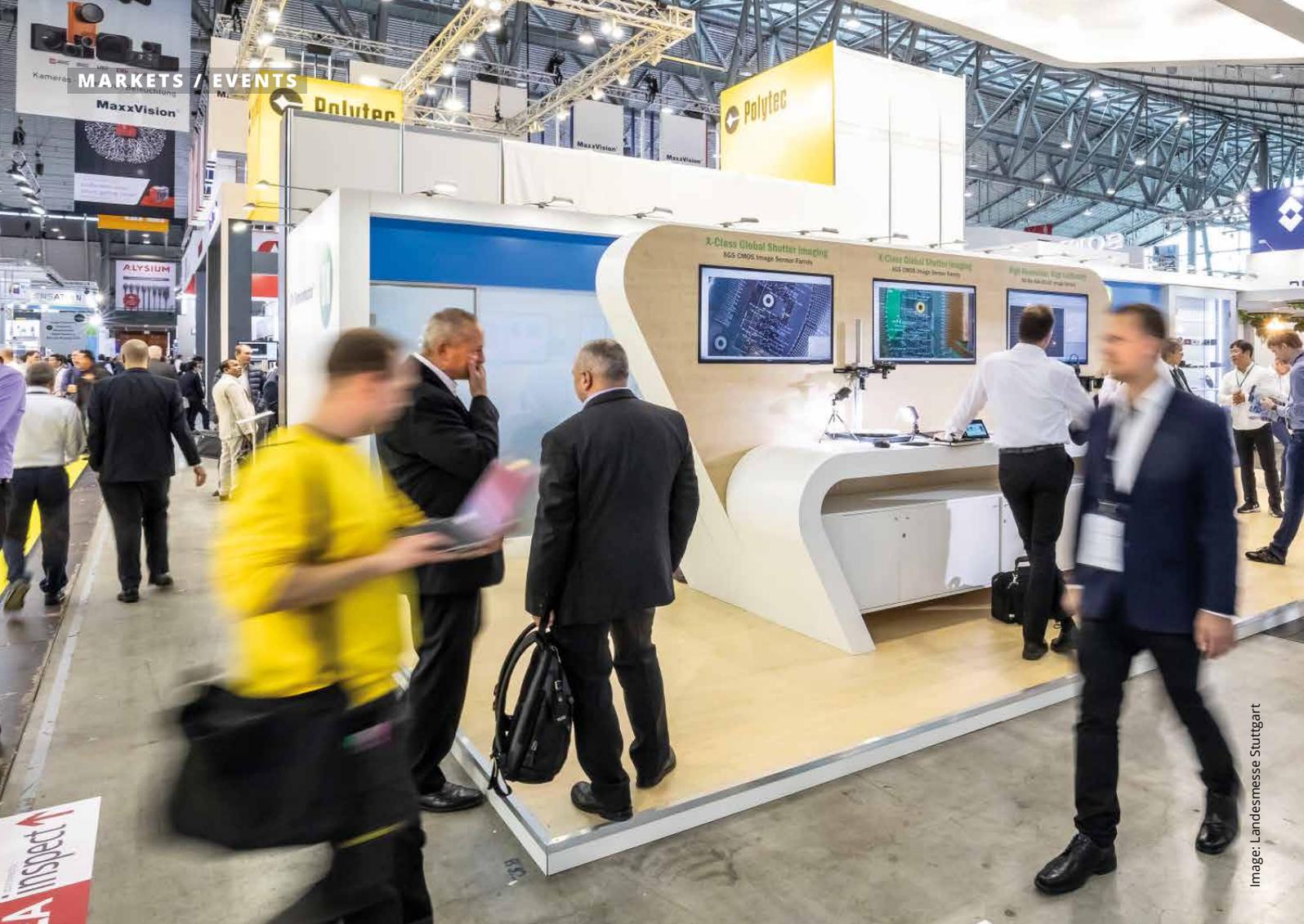
Image: Landesmesse Stuttgart

It's Vision Again

Here it is – the opportunity to finally meet in person again. Vision fair will open its doors in Stuttgart from 5th to 7th October 2021, sending a positive signal to the international market and industry.

The world's leading trade fair for machine vision: This is where the "who's who" of the industry will meet again this year, offering a unique overview of the entire range of products and services in machine vision as well as insights into the technologies of today and tomorrow. Everybody agrees that it is important that Vision 2021 takes place: "After this enforced break, we, the exhibitors, together with Messe Stuttgart, can send a positive signal to the international market and the economy and show that the industry is optimistic about the future," says Alexander van der Lof, CEO of TKH Group. "Personal encounters at trade fairs are and will remain immensely important for exchange and networking. That is why Vision

2021 is an indispensable platform!", Martin Grzymek, Sales Manager Europe at Teledyne, is also certain. Messe Stuttgart can already confirm that around every second exhibiting company will travel to Stuttgart from abroad. At the same time, it is assumed that the trade fair will have a much stronger European character this year.

Exchange 2.0
This year, face-to-face exchanges about new products and technology trends will be more prominent than before. "The exchange of complex topics and issues can in part only be clarified and explained in a personal exchange, according to the motto: just make a sketch," knows Tobias Wichmann, Managing Director of ISW.

New Players and Constellations
The trade show will also reflect the dynamics of the market: On the one hand, visitors will meet new players, such as exhibiting companies from the automation industry, and on the other hand, they will see new constellati-

ons of companies that have emerged on the market as a result of M&A activities, such as the newly founded TKH Vision Group or Teledyne: "Vision is the right setting and time to present these live to the public. And for us it is the ideal opportunity to present TKH Vision as the umbrella brand for the Vision companies of the TKH Group," explains Alexander van der Lof, CEO TKH Group.

"Many machine vision components and systems have become more innovative and cost-effective in recent years. As a result, the number of application areas for machine vision has increased significantly and this development is not only taking place in the industrial segment, but also in many non-industrial areas. Visitors to Vision 2021 will be able to gain a very good overview of current and future products, technologies and trends," explains Martin Grzymek.

Fresh Wind from Young Companies
In addition to the sponsored BMWi joint stand for young innovative companies from Germany, participants will experience new

◀ The "Who's who" in the machine vision will also meet this year at Vision and provide a unique overview of the entire range of machine vision products and services together with insights into current and future technologies.

approaches and innovative impulses at the newly created Vision Start-up World – from the latest camera technologies to software from the field of artificial intelligence or deep learning to exciting machine vision systems: "As a young company in particular, we benefit from the diverse attention of Vision: not only does the trade fair offer us a platform for our products and solutions, at the same time it is a valuable channel for understanding the needs of our customers even better and responding to them. For this reason, we would not want to miss Vision as the world's leading trade fair for the machine vision industry," reports Dr. Christoph Garbe, Managing Partner of Start-up World exhibitor HD Vision Systems.

In Stuttgart, and on the Internet

The Exhibitor Directory contains around 250 national and international industry players who have registered their own exhibition stand. Co-exhibitors from different joint stands and the start-ups taking part in the première of the Vision Start-up World must also be added. Florian Niethammer and his team expect that Vision will focus more on Europe this year due to the still existing travel restrictions and quarantine regulations.

Interested parties who cannot travel to Stuttgart this year will find all the trade fair exhibitors in the Online Exhibitor Directory. Messe Stuttgart is also transmitting the Industrial Vision Days live and on demand for the first time. The concurrent trade fairs Motek and parts2clean are also new. Participants in both guest events will have the opportunity to visit Vision free of charge and obtain information on the topic of machine vision.

Safe Expo Concept

The latest Baden-Württemberg Corona Ordinance has provided Messe Stuttgart with a good planning basis for safe implementation of trade fairs. The 4-stage plan enables the trade fair managers to safely continue the trade fair operations with the now available tools even if incident rates rise: for example, the now everyday familiar "3Gs" will be implemented on the trade fair grounds, thereby ensuring that every participant has been verifiably vaccinated, has tested negative or has recovered from Covid-19.

Corresponding test capacities are also planned on-site. The general obligation to wear a mask also applies. The mask may be removed when using a catering service or while on the outdoor areas of Messe Stuttgart. In order to ensure that participants can easily comply with the distance regulations, there will be four-meter-wide aisles and spacious catering, networking and forum areas during the trade fair. The modern exhibition halls at Messe Stuttgart will also ensure a close-meshed exchange of fresh air via a state-of-the-art building management system. ∎

Vision 2021

When: From October 5th to 7th, 9:00 to 17:00 daily

Where: Messe Stuttgart, Halls 8 and 10

Navigation address: Messepiazza 1 in 70629 Stuttgart

Parking: P26 (Entrance West)

Code for free tickets: inspect-is-visionary

For more information: www.messe-stuttgart.de/vision/en/

Small but Powerful

Interferometry in the Palm of Your Hand

Miniaturized infrared spectroscopy technology is set to benefit many applications, plus it is fast and easy to operate.

Infrared spectroscopy is a versatile tool for numerous tasks such as process analysis, sorting, healthcare, and food inspection. Since infrared light penetrates into materials, the composition of the material itself is observed instead of measuring only the surface.

This is possible due to the fact that molecular bindings are always in a state of oscillation. The infrared light interacts with those bindings and gets them to an excited state. The energy levels and thus the amount of energy needed for such a transition are unique for the respective atoms of the molecule, meaning only light of certain wavelengths is absorbed. By looking at the spectrum, i.e. the intensities of light plotted over the wavelength, samples can be analyzed qualitatively and quantitatively.

As infrared spectroscopy does not require sample preparation and measurements only take about one second, it is easy to use for the operator. Furthermore, being a contact-less and non-destructive technique, IR spectroscopy is low-maintenance, robust and hygienic. This allows accurate measurements while the sample is preserved and still usable.

How FT-IR Works

An important and widespread technique for wavelength dependent IR measurement is Fourier Transform InfraRed (FT-IR) spectroscopy. A Michelson Interferometer is one approach to distinguish the light intensity at different wavelengths:

A dichroic mirror divides the light, one part of it is directed to a fixed mirror, the other part to a movable one. Both beams are reflected back to the beam splitter where they interfere with each other on their way towards an Indium Gallium Arsenide (InGaAs) photodiode. As the movable mirror oscillates, its position is monitored with a semiconductor laser. This information and the interference pattern measured by the diode is finally translated into a spectrum using Fourier Transform. Hence, the name Fourier Transform Infrared spectroscopy.

Why FT-IR Saves Resources

The compound material InGaAs, especially extended InGaAs with sensitivity up to 2.5 μm is a challenging raw material to grow due to a lattice mismatch between the optically active InGaAs and the substrate which can lead to crystal defects. Due to this, the smaller the active area required for the detector, the higher the production yield per wafer and the lower the material cost. As the FT-IR engine merely requires an InGaAs diode, it can be more cost effective than diffraction spectrometers with comparable characteristics.

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As the FT-IR engine merely requires an InGaAs diode, it can be more cost effective than diffraction spectrometers with comparable characteristics.»

Labels: InGaAs PIN photodiode · Si PIN photodiode · VCSEL + thermistor · Dichroic mirror · Incident light · Infrared interferometer · Beam splitter · MEMS chip · Laser interferometer
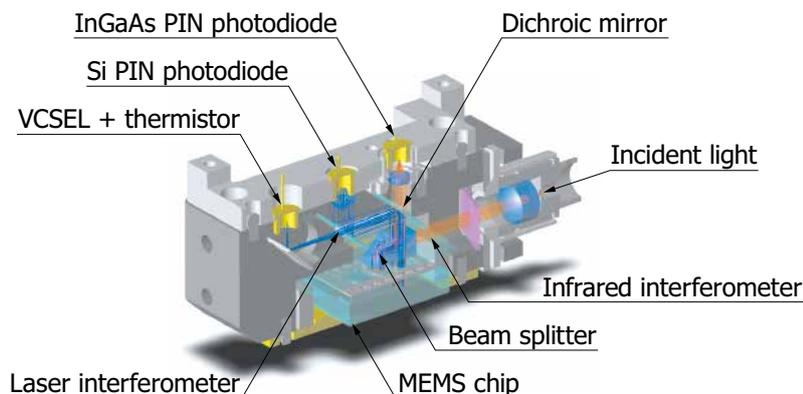
By using their own unique MEMS technology, Hamamatsu have reduced the size of the FT-IR spectrometer so the whole device fits in a palm, enabling interferometry within handheld systems.

Compactness and High Accuracy Achieved with MEMS Technology

Generally, FTIR features high resolution and high-speed measurement. The "FTIR engine C15511-01" is a compact Fourier transform infrared spectroscopic module with high sensitivity to near infrared light in the range of 1.1 μm to 2.5 μm. A Michelson optical interferometer and control circuit are integrated into a palm-sized housing.

The optical interferometer is the biggest part of such a device, making most FT-IR spectrometers bulky bench-top instruments. We have made our FTIR engine more compact while retaining the features of the Fourier transform type by applying our unique MEMS technology to the optical interferometer. This enables interferometry within handheld systems.

In order to achieve optimum optical characteristics despite miniaturization, a large 3mm dia. movable mirror ensures high sensitivity up to 2500 nm, equivalent to tabletop devices.

Detection Performance Comparable to Previous Stationary Type Devices

The MEMS actuator, a mirror of 3 mm diameter, ensures an efficient minimal loss of the reflected light. Using our mounting technology cultivated over many years, we have integrated the movable mirror and the fixed mirror as a MEMS chip, thereby making it compact and reducing error in the relative angle between the mirrors to about 1/100. By optimizing the structure and drive method of the MEMS actuator and eliminating shaking when in operation, we have suppressed the spread of infrared light inside the optical interferometer and reduced loss. By doing this, we have achieved detection performance comparable to previous stationary type devices.

Additionally, the outstanding resolution and the great signal-to-noise ratio ensure that Hamamatsu's FT-IR engine is suitable for sophisticated tasks such as:

76 mm · 68 mm · 49 mm

- environmental monitoring in the field,
- ingredient analysis of agricultural products,
- quality control in factory production,
- food or plastic sorting at the store,
- point of care testing for human health at home. ■

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All images: Hamamatsu

Image: Dmitry Kalinovsky/shutterstock

Waterproofing Your Machine Vision Application

Challenging Environments Require Innovative Solutions

Demands placed on machine vision systems continue to reach new heights, and as technology continues to develop, a growing number of machine vision applications are calling for high-performance imaging systems, frequently going beyond the capabilities of standard imaging lenses.

Applications in food, automation, and robotics often operate in environments with elevated amounts of vibration, shock, moisture, and changes in temperature, each coming with its own set of requirements and challenges. These demanding conditions and environments can cause a multitude of issues in vision systems, and new classes of specialized lenses are being designed to work in these challenging scenarios.

Currently, there is little in the market specifically designed for applications where imaging systems can come into contact with water, such as submersion, water sprays, or even nature's elements. To combat this issue, Edmund Optics has developed an innovative new series of imaging lenses, the Techspec Cw Series Fixed Focal Length Lenses, that are completely waterproof and specifically designed for applications where the imaging optics may be subjected to water in one way or another.

But How Waterproof is Waterproof Really?

To better understand how protected an imaging lens truly is with regards to water, it is important to look at its IEC ingress protection (IP) rating.Ingress protection ratings classify the degree of protection mechanical casings (in this case, imaging lens housings), have against solids and liquids. The first digit of the IP rating specifies a lens' intrusion protection against solids (e. g. dust). This digit starts at "0" or "X" and goes up to six where "0" or "X" is no protection from solids at all and six is total protection from dust. The second digit denotes the protection from moisture. Similarly, it starts at "0" or "X" where there is no protection from

Image: Edmund Optics

Waterproof lenses, such as the Techspec Cw Series Fixed Focal Length Lenses, are an optimized, harsh environment option.

moisture at all, but goes up to nine, where there is complete moisture protection.

Moisture protection is achieved by including a silicone O-ring behind the front window of the lens, and another in front of the front focusing element, providing two layers of protection to the front optic. This significantly reduces the chance of lens failure and water leakage into the system. Also present is an

extra groove at the back of the lens assembly which allows for an additional O-ring to be placed between the camera and lens should extra sealing be required. Additionally, a hydrophobic window is situated at the front of the assembly to protect the first lens element from water droplets.

Generally, the ingress protected lenses currently available in the market are moisture protected to a 7, 8, or better. Edmund Optics' Cw Series meet IEC Ingress Protection Codes IPX7 and IPX9K and can withstand exposure to water up to 1 meter deep for 30 seconds and operate in close-range high pressure, high temperature water spray downs. Lenses such as these are typically used in applications where a full enclosure of the entire imaging system is not possible.

Protecting Imaging Systems Becomes Easy

Whilst waterproof cameras meeting these IEC ingress protection standards have been around for a while, compatible lenses with the same level of protection were previously not available. Thus, to protect the machine vision system, the entire unit would need to be enclosed in a protective cover so that water would not enter the lens. However, the addition of this cover increases the size and weight of the system and prevents direct access to the lens. Should modifications need to be made to the focus of the lens, the entire system would have to be disassembled: an inefficient and laborious process.

Full-system coverings such as these are particularly troublesome in space-constrained applications or wide-angle systems since they will limit the lens' field of view. They will also require a bigger enclosure due to the lens' characteristic larger sizes and protruding front elements and the bigger the enclosure, the higher the cost of the overall system will be.

Using waterproof lenses eliminates the need for bulky and cumbersome protective covers since both camera and lens are individually waterproofed. This enables for the lens and camera to be directly integrated to one another, providing a less expensive, more compact yet still sealed option which can be easily handled in situ.

There are still currently very few waterproof machine vision imaging lenses available on the market, and even fewer include a hydrophobic coated window at the front of the assembly such as that featured on the Cw Series models. The hydrophobic coating prevents water droplets from settling on the lens' surface and obscuring the acquired image, allowing it to still be focusable in harsh environments without removing it first for cleaning. Conveniently, the hydrophobic windows may also be easily removed and replaced should they become damaged during use, avoiding the costly requirement to replace the entire optic.

Extra Ruggedization for Harsh Environments

Ingress protection waterproofing technology is also often coupled with additional ruggedization features, such as in the Cw Series since many of the same applications where imaging systems may be exposed to water can also expose them to other forces such as vibration and shock.

To mitigate the adverse effects of such environments, these lenses are fitted with a reduced amount of moving parts to make their housing mechanics more stable and robust. Conventional fixed focal length lenses have variable apertures. Their iris is composed of many delicate leaves which slide together to adjust the aperture, and, if exposed to vibration, can jitter inside the lens housing, causing them to become loosened or dislodged. Instead, for waterproof versions, the variable iris is removed and a fixed aperture is put in its place, increasing the survivability of the lens and ensuring that the f-stop remains unaffected by vibrations.

Conventional lenses also feature a double-threaded barrel focusing system with a focusing ring and bulky thumb screw to keep the mechanism in place once a desired focus is achieved. In applications where shock and/or vibration are also present, this thumb screw can become displaced, and the focus setting may change. To prevent this from happening, the two-threaded barrel and screw mechanism is replaced by a simple single thread focusing system and rigid lock nut or set screw which does not protrude and cannot easily be knocked or displaced.

Overall, the slimline design and removal of moving working parts adds an extra level of ruggedization, robustness, and survivability to the lens to help it achieve optimum function in harsh environments.

As automation spreads to every corner of manufacturing and autonomous systems, machine vision system integrators are starting to include lenses into application sectors where they had never been used before. Many of these applications experience harsh environments with water exposure, shocks, and vibrations. Waterproof lenses, such as the Techspec Cw Series Fixed Focal Length Lenses, are an optimized, harsh environment option ideal for these new application spaces including food, pharma, automation, and robotics. ∎

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With Unity, the science community receives an all-in-one tool that is compact and portable enough to be suitable for bench-top use.

Laser Free Confocal Microscopes

A Specially Designed sCMOS Camera Was Used to Develop an All-in-One Microscope

A new confocal microscopy system speeds up and facilitates the imaging process and reduces costs. The small component size enabled mass production.

Confocal microscopy is a well-known and popular approach improving the conventional widefield optical microscopy with several major advantages. Modern confocal microscopes are fully integrated digital systems consisting of detectors, computer, laser and a beam scanning assembly. It is a relatively sophisticated task to come up with novel functionality that would benefit the customers using these systems in various scientific fields.

Aurox is an optical imaging manufacturer based in UK with an experienced team of experts successfully offering such advancements for over 15 years. Their latest system called Unity makes confocal microscopy faster, easier, more affordable, and accessible for wet lab biologists and medical re-

searchers. To finalize it for mass market the newest technologies were required allowing to miniaturize the components thus making the end product extremely compact and self-contained. For this purpose, the manufacturer's team decided to collaborate with an innovator who was able to provide an OEM solution suitable for the demanding goals. When a unique approach and agile implementation are important, Ximea is eager to help with the experience and the latest technological achievements.

All-in-One System

Essentially, Unity is an all-in-one laser free bench-top confocal microscope, fully integrated, compact, easy to access, move, maintain/clean and use. Its construction is making it the ideal confocal microscope for use in the CAT-3 laboratory and allowing for the use of typical decontamination procedures. It combines Aurox's patented laser free confocal technology with proprietary structured illumination spinning disc and state of the art unique optical arrangement. Integrated

inside is the proven multi-spectral LED light source based on the CoolLED pE-300Ultra.

The low magnification overview objective lens (3.25x) used for bulk sample imaging is complemented by a high magnification lens for detailed study. The high magnification lens is customizable and can be selected during the order process from 20-60x magnification Nikon oil, water, or dry lenses.

Switching between low and high magnification is virtually instantaneous and the decoupling of the respective lenses allows to change back and forth at any time without the need to adjust the focus. Remarkable is also the optical path that allows sample imaging from both above and below the sample, providing confocal and widefield imaging whilst maintaining an extremely compact size.

Instead of moving the sample stage up and down, Unity moves the objective lens. The high magnification objective is mounted on a piezo motor Z-drive and focusing is achieved by moving the objective closer or farther away from the sample.
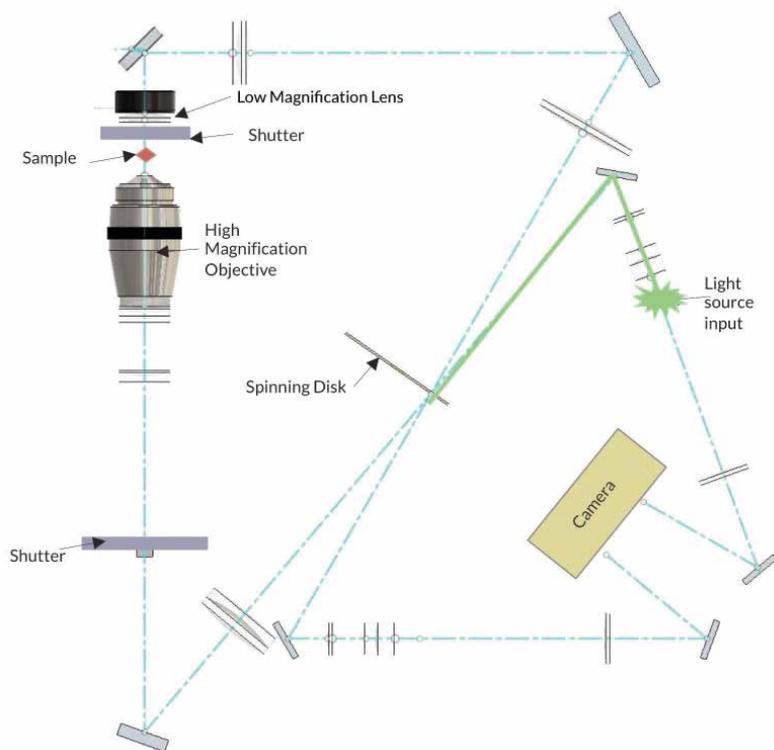
Overview of the imaging process

For Bench-Top Use

Intended for laboratory bench-top use, Unity is very compact with dimensions of 222 x 399 x 482 mm and a weight of 22 kg. The microscope reduces the number of cables and keeps only a single one for power with an optional network cable. Rear ports add the connection of a CO_2 gas supply which leads to sample incubator. Its motorized XYZ stage is designed for use with a wide range of samples and sample mounts.

The incubator heating and CO_2 enables environment control, allowing live-cell samples to be maintained at 35-37°C for the duration of long-term imaging experiments.

The system is free of laser safety restrictions while providing the benefit from low photo-toxicity, low photo-bleaching, low maintenance and low cost of ownership. Unity is supplied with three interchangeable sample holders allowing to image all samples, whether they are mounted in multi-well plates, Petri-dishes or slides. Each of the microscope's sample holders has a retention system to hold the sample securely in the holder and a three-point magnetic location system that connects to Unity's XY stage on loading. Typical microscope stages carry the sample, sample mount, incubator, and most of all the heavy microscope stage itself. These all ride around supported and driven by necessarily large heavy duty motor assemblies.

Unity only moves the sample and sample mount in our holder, the rest is gliding.

This is because there is no need to move the stage in Z and the sample holder sits on a low friction glass plate over which it glides like a hockey puck around X and Y pushed by two ultra-compact precision magnetic motors. The final touch is the structured illumination spinning disk with a novel optical arrangement.

At the heart of Unity is a specially designed large format, high performance sCMOS camera from Ximea with two top quality scientific grade sensors. These sCMOS detectors are recording high resolution confocal and wide-field images as well as

A compact bench top for laboratories
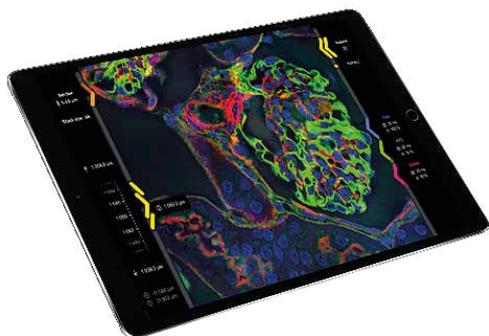
Unity is supplied with a user-friendly table.

ultra-large field of view (4 x 4 mm) full over-view images of the sample.

Integrated Tablet Computer

After collecting high quality confocal imaging data, the next task is to store them most effectively on 2x removable 2Tb SSD servers. There the data is kept in an integrated image server database and is accessible to the users wherever they are over a secure network.

For ease of user interface and control, Unity comes equipped with a large format tablet computer. The tablet communicates directly with the microscope over a dedicated and secure private wireless connection.

To speed up the data stream response, images are optimized for fast feedback and display on the iPAD. The full high resolution collected images are permanently stored on Unity's internal built-in server.

Software calibrated for the use with the provided tablet is intuitive and presents all device controls for experiment set-up in one color coded workflow.

Located under a single graphical UI window this workflow process can be managed with simple swipes, expansions, or other finger gestures.

The software enables:
- sample holder, overview and high magnification modes,
- Z-stack, Tilescan, Time-lapse, Multi-channel imaging,
- confocal, wide-field & bright-field modes,
- multiple regions of interest,
- environmental control,
- OME-TIFF (Open Microscopy Environment - Tagged Image File Format).

The iPAD works as a remote control, issuing commands like tap, drag, swipe and receiving feedback. All command actions are controlled by Unity's internal control software and firmware. For a closer look and post processing, the Unity OMETIFF image data can be read directly into a wide range of third-party image processing software, including:
- DRVision Aivia,
- Image-J/Fiji,
- Image Pro Premier 3D,
- Andor Imaris.

Unity data is fully compatible with post processing algorithms such as 3D SRRF, SOFI, Huygens and on the fly deconvolution with Microvolution.

A Fruitful Cooperation

In the previous devices, the Aurox team was using as detectors the components from the established scientific camera vendors. In the case of Unity, they needed something special, not yet on the market - with high sensitivity and speed while being able to be embedded and fit in tight space.

For the Quantum efficiency aspect and low noise, a pair of 2K x 2K sCMOS sensors were chosen to work side by side in a synchronized way, with shared electronics and pixel to pixel registration.

To achieve the high enough speed and lowest latency the PCIe interface was picked as a suitable technology. For the host providing high enough performance, a module from the NVIDIA Jetson family was selected.

In order to reduce the temperature to a minimum, the sensor head needed to be separated from the heat source and work

The large format sCMOS camera from Ximea has two top quality scientific grade sensors that record high resolution confocal and wide-field images as well as ultra-large field of view (4 x 4 mm) full overview images of the sample.

remotely. Combining all of these requirements together and making the final product as small as possible was a job perfectly cut out for Ximea team. The result was OEM camera component with dual sCMOS sensors on one board with close sensor-to-sensor placement to match the miniature form factor. The final size of the custom board is similar to that of a PCIe x4 Gen3 adapter card which is plugged directly into NVIDIA module. An additional advantage is that the Aurox software is receiving the images via PCIe straight into the GPU memory for seamless processing.

«

Instead of moving the sample stage up and down, Unity moves the objective lens.»

High Performance

With Unity, the science community receives an all-in-one tool that is compact and portable enough to be suitable for bench-top use. The patented spinning disc technology utilized in this confocal microscope is combined with its benefits from being laser free. User friendly workflow and easy software control over the complimentary tablet are enhanced through simple data storage and safe access to it from anywhere. The most important however are the resulting images and here Unity offers high resolution, high quality pictures delivered fast and processed instantly. The small form factor is intended for installation and uses where samples are generated, removing the immediate need for travel to a core microscopy facility. Applications for this high-performance integrated microscope system, that accommodates low photo-toxicity and low photo-bleaching can be found in entomology and cell biology. ■

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All images: Ximea

AI vision kit introduced

For proof of concept, rapid prototyping and small series production, AU-Zone and Toradex, working in close cooperation with Vision Components, have developed the modular Maivin i.MX 8M Plus AI Vision Kit. The developer kit is based on a Toradex Verdin i.MX 8M Plus System-on-Module and a carrier board, which AU-Zone designed for vision applications and which accommodates up to two VC MIPI camera modules. The kit is scheduled to be ready for shipping in Q3 2021.

Featuring a neural network processor unit and an integrated image signal processor, the i.MX 8M Plus processor from NXP is ideally suited for demanding embedded vision applications. The Verdin SoM for the kit has been extended by a variable SoM adapter and connector board from AU-Zone in order to enable users to quickly and easily build functional models on its basis. Together with the high-quality camera modules VC MIPI IMX327-C (color) and VC MIPI IMX296 (monochrome), customers have access to all components for image acquisition as well as the required interfaces and I/Os for individual rapid prototyping solutions up to small series. Additional VC camera modules are also compatible with the Maivin kit.

www.vision-components.com

Series of ring lights

With the LR45 series, another high-performance high-power ring light from Lumimax is now available. The lights distinguish themselves by their compact design and can be used even in challenging industrial environments.

With a free inner diameter of 45 mm, an outer diameter of 100 mm, a design height of 25 mm and a weight of just 250 g, the LR45 is very compact. The three-dimensional cable outlet on the back enables highly flexible electrical integration of the light. Rear mounting threads and versatile accessories allow uncomplicated mechanical connection to various cameras and sensors. With the aid of separately available lens adapters, the light can, for example, be screwed directly to the lens or protective tube of the camera. This makes the LR45 a choice for use in confined spaces as well as in motion handling and robot vision systems – even under demanding industrial conditions thanks to IP64 protection.

Despite its compact exterior, high-performance integrated controller technology for either continuous, switched or flash operation mode is hidden inside the LR45. In addition, the light has high-speed trigger inputs and the option of brightness control.

The 24 built-in high-power LEDs are available in the light colours red, white, blue, green or infrared. The irradiance characteristics of the light can be adjusted to the application with the aid of ancillary lenses. The lenses are mounted in lens arrays, enabling quick and uncomplicated lens changes – even with mixed mounting of lenses with different beam angles.

www.iim-ag.com

X-ray cameras based on sCMOS

Ximea discontinued their CCD sensor products and replaced them with sCMOS and CMOS sensors. One of the primary benefits that sCMOS and CMOS sensors hold over their CCD counterparts is speed, which is harnessed using fast interfaces such as USB3, PCIe or Thunderbolt. High dynamic range, crystal clear 16 bit images are provided from these sensors thanks to the combined high and low gain readout.

Image output can be adjusted utilizing various imaging modes provided by the camera software to optimize for single pixel full well capacity and noise to maximize SNR. Long exposures are enabled by cooling the sensors with Peltier coolers to again match or exceed the capability of CCD based cameras.

To summarize, there are new models planned for introduction into Ximea portfolio of X-ray cameras. They are developed with different parameters, like 15 Mpix, Gpixel GSENSE5130, X-ray camera, FOV 21.5 x 12.6 mm, 4.25 µm pixel, GadOx:Eu 10 µm thick, 17 Fps with USB3.

www.ximea.com

Camera models for special requirements in factory automation

Strong and sturdy: uEye FA industrial cameras are particularly robust and therefore ideally suited for demanding environmental conditions, for example in factory automation. Starting in August, IDS will offer three new sensors in the family: The 12 MP (IMX226) and 20.44 MP (IMX183) Sony sensors are true high-performers with high resolution and low noise. For special requirements, the company will also integrate the 5 MP polarisation sensor IMX250MZR.

Housing of the uEye FA models, lens tubes and the screwable connectors (8-pin M12 Ethernet connector with X-coding and 8-pin Binder connector) meet the requirements of protection class IP65/67. The GigE cameras can be operated either with 12-24 V or alternatively as a PoE setup (Power-over-Ethernet). PoE enables practical single-cable

operation up to a maximum length of 100 m. The cameras are typically used for machine vision tasks in industrial plants and quality assurance. Software support is provided, for example, by the modern IDS peak SDK.

www.ids-imaging.com

Fighting Forest Fires

A Combination of Software with AI Functions, Monochrome and Color Cameras
As Well As an NIR Camera Enables a Monitoring Radius of up to 60 Kilometers

The Portuguese resort of Sintra protects its cultural landscape with the IQ FireWatch forest fire early detection system from the Berlin-based company IQ wireless. Software with AI functions evaluates semi-automated image data provided by three industrial cameras.

The small Portuguese city of Sintra is a popular tourist location, not least due to its picturesque nature park and palaces, some of which are several hundred years old. As a result, it was classified as a Unesco World Heritage Site in 1995. The danger of forest fires to the area is therefore very serious. For this reason, a system for the early detection of forest fires has been installed on the National Palace of Pena for many years – IQ FireWatch. Both the early detection, precise localization, and, if required, direct alarm forwarding, are crucial for the prevention of catastrophes. In January 2019, the monitoring system was modernized and equipped with three industrial cameras from Baumer. The combination of a monochrome and color camera as well as

a camera with particularly high near-infrared (NIR) sensitivity ensures a monitoring radius of at least 15 kilometers, with good weather conditions even up to 60 kilometers. On site in the monitoring tower, a feature-based algorithm and AI evaluate the image data of the cameras and, in case of suspicious findings, alert an operator within approximately three minutes who then decides on the next steps. The harmonious interplay between the cameras and the recognition algorithm allows the detection of forest fires shortly after they occur and minimizes the risk of false alarms.

**Precise Image Capturing
Around the World**

Sintra is not the only location to employ the state-of-the-art early detection system. Around 350 IQ FireWatch systems are active around the globe, from Brandenburg in Germany to California in the United States. The different weather conditions pose special challenges to the hardware – especially in warmer locations such as Portugal or the western United States, heat can be detrimental to cameras. A system failure would be the worst-case scenario. Other than that, high temperatures can also decrease the

productive life of the equipment and lead to interference such as noise in the images, which can impede the detection of fires.

**Minimum Service Life of 10 Years
and Temperatures up to 65°C**

Therefore, the high operating temperature range of the VCXG-24M (monochrome), VCXG-24C (color), and VCXG-22M.R (NIR) cameras was a crucial factor in the decision: "When it comes to our components, we attach importance to a long service life of at least ten years," says Dr. Kurt Winter, managing director of IQ wireless. "If you are constantly at the edge of tolerances, you put that at risk. Therefore, the fact that Baumer cameras function at up to 65°C instead of the standard 50°C was a key argument for us." Prior to that, IQ wireless used self-constructed camera systems. Tests with cameras from Baumer and another manufacturer, however, found that the Baumer cameras clearly provided images with less noise and a very high dynamic range, which made the detection by the software system considerably more accurate and resistant to error. At the same time, the cameras can be installed as desired thanks to their circumferential M3 fastening – for mountainous regions, for

All images: IQ wireless

Three industrial cameras from Baumer are concealed in a pan and tilt head. A 360-degree detection requires between four to six minutes in the daytime and approximately 12 minutes at night.

example, an installation that can be rotated by 90 degrees is advantageous. "It is simply a perfect interplay of hardware and software," explains Winter. "Plus, thanks to the Baumer GAPI software development kit, the cameras could be easily and smoothly integrated into our existing system. It was therefore easy for us to decide on Baumer."

Semi-Automated Fire Detection

Currently, a 360-degree detection in Sintra requires between four to six minutes in the daytime and approximately 12 minutes at night. For this purpose, the three cameras

are installed on the top of a tower of the national palace in a pan and tilt head and operate according to the principle of divided roles – the monochrome camera handles the visual inspection of large ranges, while the camera with high NIR sensitivity is used especially in bad light conditions and at night. At this time, the images of the color camera are used mainly to offer the operator an additional orientation aid for making the decision whether a message really concerns a fire. In future, however, its data will also be included in the automated detection.

The processing unit uses a feature-based algorithm to separate the different characteristics of smoke, clouds, and fog, thus allowing them to be differentiated. The combination with an AI in the form of an artificial neural network that is constantly trained with new information and data further increases the accuracy of the detection. Only when the processing unit identifies a fire with a high degree of certainty is a message issued to an operator, who uses the captured images to decide whether to instruct the system to inform the fire department.

Using Knowledge from Space Travel for Applications on Earth

The basis for this system was laid 20 years ago in a collaboration between IQ wireless and the German Aerospace Center (DLR) and allows knowledge gained from space travel to be used on earth. For the Rosetta mission, the DLR developed a solution to determine the material composition of the Rosetta comet, especially based on the gases it emits. This quickly led to the idea that this solution could also be used on earth to detect forest fires. After, all these can also be detected by the gas they emit – first the evaporating liquids of the forest floor, then the smoke particles and combustion gases. This idea resulted in a collaboration between DLR and IQ wireless, which resulted in the IQ FireWatch system that was first installed in the late 1990s in the Brandenburg Forest. In 2012, the collabora-

tion partners for this successful application of space technology on earth were included in the US Space Foundation hall of fame.

Managing director Dr. Kurt Winter is proud of this recognition, which was awarded for the first, and so far, only time to a non-US technology. He is equally pleased to have found the ideal complement in the Baumer cameras on the hardware level. "In such systems, reliability is a top priority – after all, human lives are at stake," he explained. "With their robust design, low energy consumption, and extensive operating temperature range, the cameras from Baumer offer exactly the characteristics we are looking for. In addition, their precision makes the system reliable in the sense that we are able to limit the number of false alarms to a minimum." Of course, it is equally important for the support team to react quickly and competently. "When it comes to this in particular, our development engineers are full of praise because all inquiries can be resolved quickly, competently, and helpfully."

The IQ FireWatch system is already providing more safety in Sintra and at many other locations around the globe, while being constantly improved at the same time. In the future, for example, weather data will be incorporated into the detection algorithm to increase the accuracy and to improve further the already effective and efficient system for protecting human beings, nature, and culture. ■

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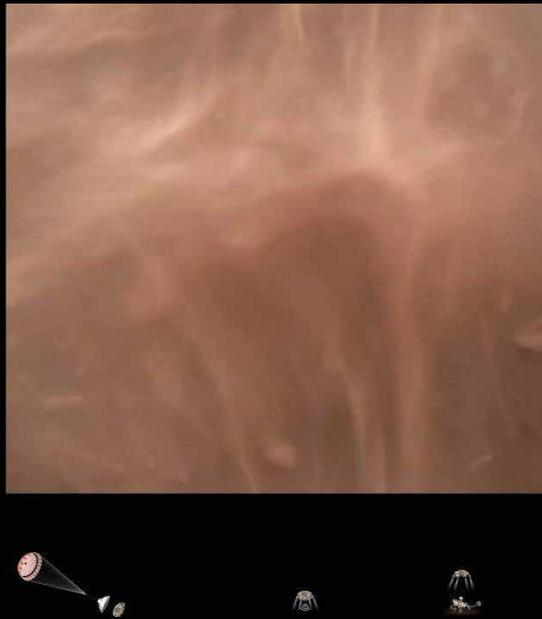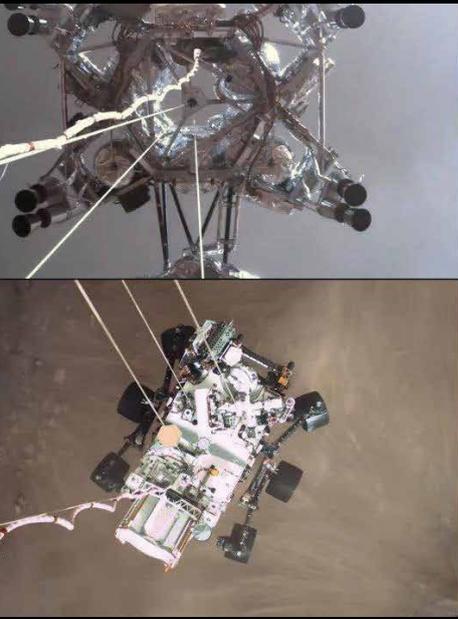
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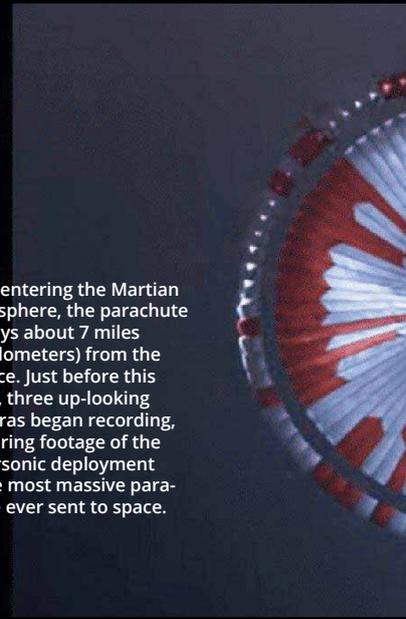
1.
After entering the Martian atmosphere, the parachute deploys about 7 miles (11 kilometers) from the surface. Just before this point, three up-looking cameras began recording, capturing footage of the supersonic deployment of the most massive parachute ever sent to space.
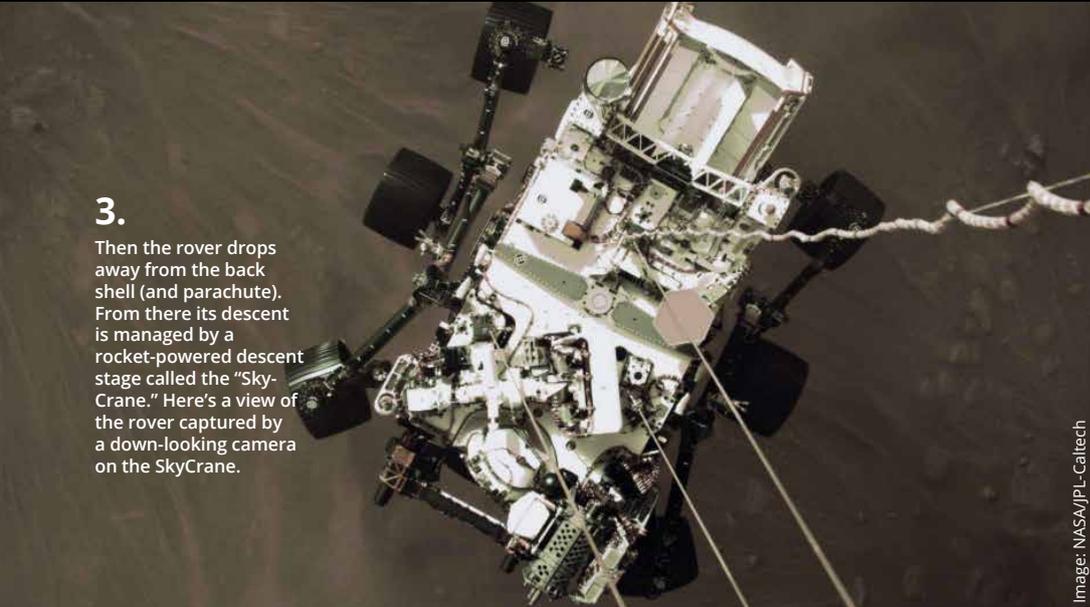
3.
Then the rover drops away from the back shell (and parachute). From there its descent is managed by a rocket-powered descent stage called the "SkyCrane." Here's a view of the rover captured by a down-looking camera on the SkyCrane.

4.
Then it's touchdown! Here's a view (from a camera on the rover) of the SkyCrane being swept away as the rover touches down on the surface of Mars to begin its mission.

Image: NASA/JPL–Caltech

Machine Vision
in the Vast Expanses of Space

Industrial Cameras Film Mars Landing of Nasa's Perseverance Rover

For the first time, detailed footage of a Mars landing is available from several angles. This was made possible, among other things, by six industrial cameras from a U.S. manufacturer. The fascinating images show how complex the maneuver was and give an impression of how robust the technology had to be.

Image: NASA/JPL–Caltech

2.

Five miles off the ground, the heat shield (used to protect the rover during entry into the Martian atmosphere) drops off and exposes the rover down-look camera, showing some of the rover's intense ride to Mars' Jezero Crater:

Image: NASA/JPL–Caltech

Image: NASA/JPL-Caltech
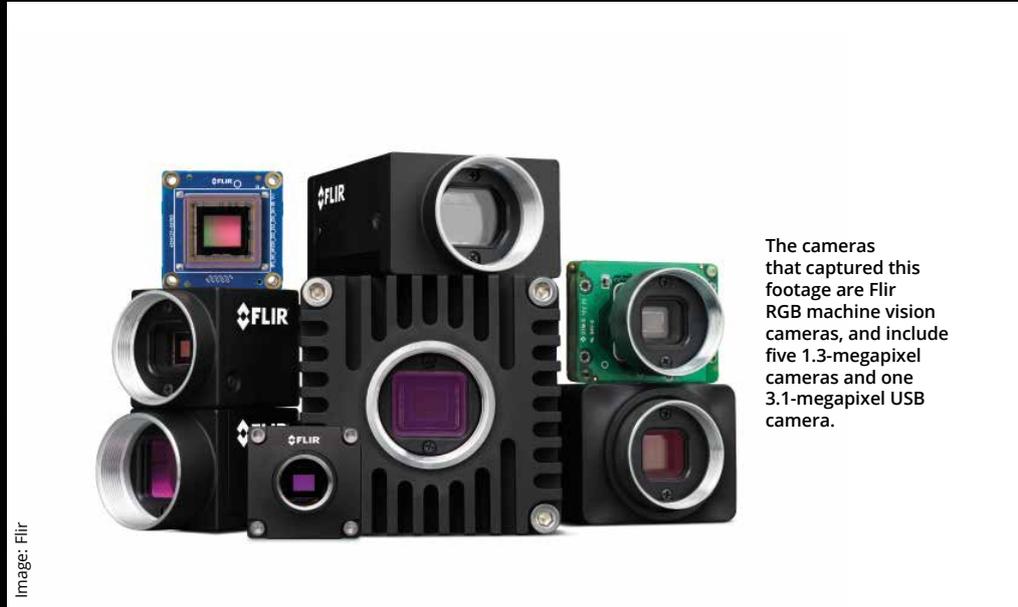
Image: Flir

The cameras that captured this footage are Flir RGB machine vision cameras, and include five 1.3-megapixel cameras and one 3.1-megapixel USB camera.

On February 18th, Nasa successfully landed the Perseverance Rover on Mars. This isn't the first Mars mission, but it was the first time that the entry, descent, and landing of a spacecraft was filmed and broadcasted live for the public to watch and virtually participate in. Six Flir machine vision cameras captured the event from multiple angles, documenting all stages of the thrilling touchdown. While only a few minutes long, the footage has already helped engineers evaluate how well their work performed in space, and inspired millions of viewers around the world.

The Entry, Descent, and Landing (EDL) of the rover may only be a few minutes long, but there's a lot going on in those few minutes – always captures by Flir's cameras.

"Our cameras are designed for operation on Earth, and not built to operate in outer space," said Sadiq Panjwani, VP of the Integrated Imaging Solutions (IIS) division at Flir. "So, we were quite thrilled that Nasa put them to the test."

Nasa began contacting Flir in 2015 to investigate suitable cameras for the EDL (Entry, Descent Landing) system. Engineers were looking for commercial off the shelf (COTS) hardware with an emphasis on low cost and ease of system integration.

This is the first time that Flir machine vision cameras have been subjected to the extreme temperatures or high gravity forces experienced during the Mars land-

ing. Everyone involved in engineering and manufacture of cameras at Flir is thrilled about this testament to their durability and performance. And of course, ecstatic to say that their work has made it to Mars! ∎

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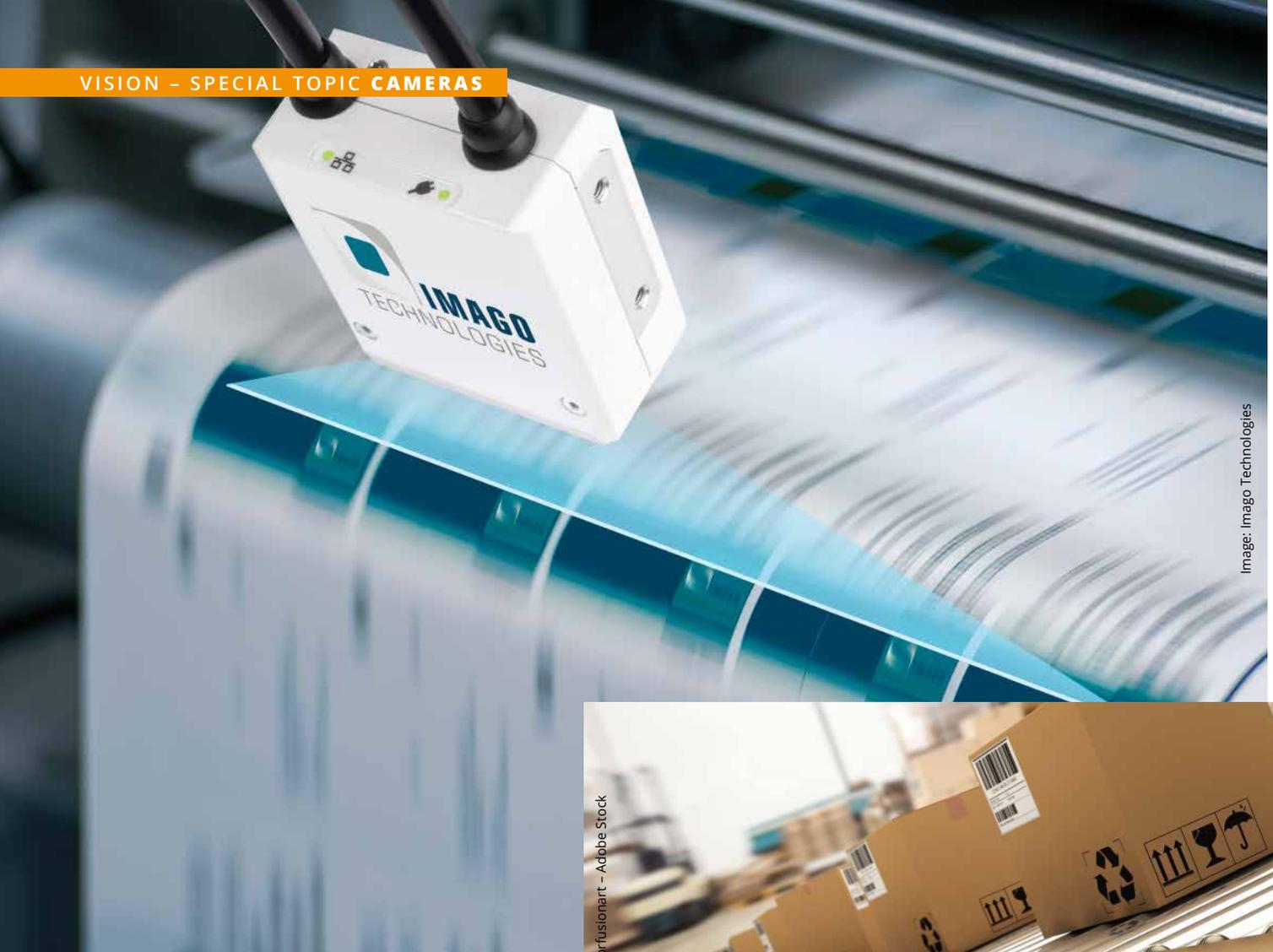
Image: Imago Technologies

Image: vectorfusionart – Adobe Stock

Packages of different sizes and lengths with relatively small codes on them are a perfect fit for line-scan technology.

Mastering Variety

Line Scanning Is an Optimal Solution for Variably Sized Inspection Objects

A compact and economical solution for very long or differently sized inspection objects makes it easy to get started with line scan camera technology thanks to its embedded system.

When packages of different sizes and lengths whiz by on the conveyor belt, it is difficult for conventional matrix cameras to inspect relatively small codes on them. But area scan cameras also face challenges when inspecting very long and narrow objects as well as continuous material. Image processing systems based on-line scan technology are often the only technically and economically feasible solution.

However, the use of line scan cameras is often met with skepticism. Perhaps caused by the lack of experience with the technology. Consequently, image processing users continue to use matrix cameras even when the use of line scan camera technology would make more technological sense. Yet the Vision Sensor LM from Imago Technologies, with its combination of camera, illumination, computer, and algorithm, offers a simple and economical way to illuminate inspection objects, generate high-resolution images and evaluate them directly in the camera using the appropriate software - and all this in a device the size of a matchbox.

"With the Vision Sensor LM, we want to encourage machine vision users to get into line scan camera technology," explains Managing Director Carsten Strampe.

«

With the Vision Sensor LM, we want to encourage machine vision users to get into line scan camera technology.»

Functional Principle of Area Scan Versus Line Scan Camera

Unlike area scan cameras, which use a matrix-shaped sensor to simultaneously capture a two-dimensional image, line scan

cameras use a single line-shaped sensor line to capture a large number of individual lines in very rapid succession. This results in either an endlessly long image or at least an image with many lines via sensor information. Compared to a classic line scan camera, the Vision Sensor LM offers a feature for easy setup of, e. g., sharpness and camera param-

The free setting options for the area of interest are optimal for inspecting relatively long and narrow objects such as cereal bars.

eters. In standstill, it is possible to switch to area mode so that an image can be seen in the software. In matrix mode, lens and camera parameters can be conveniently set and then switched to line mode.

According to Managing Director Carsten Strampe, "the Vision Sensor LM is a smart line scan camera with an area sensor and, together with a quad-core ARM CPU, is a globally unique product for computer vision. It provides users with an intelligent and compact line scan camera solution that offers tremendous flexibility in switching between different area and line-scan modes."

Capture the Test Object with Precision Using the Area of Interest
How many lines are captured at a time is yet another parameter which can be set by the user, thus allowing the image capture to be tailored to the application. Strampe explains: "The 2-megapixel version, for example, can be set to an Area of Interest (AOI) of 1,920 x 2 pixels at a maximum achievable frame rate of 13.8 kHz which corresponds to 27.6 kHz for a single-line sensor. The achievable line frequencies are quite sufficient for many standard applications."

The flexibility of the Vision Sensor LM continues with the options for the lenses: It can be selected with a connection for M12 or C-mount lenses, depending on the task. The Vision Sensor LM can thus be precisely matched to the requirements of the application in question.

The Line Scan Camera for Beginners
With its combination of camera, lighting, computer and freedom in algorithm, the Vision Sensor LM offers an easy entry into line

scan camera technology. The Vision Sensor LM is equipped with integrated LED illumination, which already provides sufficient light for many tasks to enable meaningful camera images. Alternatively, external line lights can be used. A state-of-the-art quad-core CPU as well as Linus Debian 10 as operating system guarantee the performance of the Vision Sensor LM. Flexibility is provided by the ViewIT application program.

ViewIT is made to reduce the effort necessary for the machine vision application development to a bare minimum. The particular strength of ViewIT is that this framework automatically takes over all the tasks around the actual image processing, including image acquisition, I/O handling, the GUI and many other tasks, so that developers can fully concentrate on solving the image processing task. Nuances related to image capture with line-scan camera make such machine vision applications complex and unattractive for most developers. ViewIT and the Vision Sensor LM reduce development time of line-scan camera-based vision application to ordinary image processing. Thus, allowing broader audience of developers to solve this type of tasks.

Computing Power in a Compact Form Factor
Due to their properties, line-scan cameras are usually relatively large. Vision Sensor LM impresses with its very compact dimensions of just 45 × 54 × 25 mm in the S-mount version including the optics, or 50 × 39 × 50 mm in the C-mount design without the optics. The integrated quad core processor ARM Cortex-A53 allows evaluation of the captured image in real-time directly in the camera.

The miniaturized Vision Sensor LM offers an effective way to enter line scan technology, Strampe is convinced: "Due to its compact format, which includes illumination, camera, computer and algorithm in one housing, the vision sensor is optimal for image processors who are considering line scan technology for themselves."

If requirements increase, the big sister Vision Cam LM or a combination of Vision Box and separate camera are available. Carsten Strampe notes: "As far as line scan camera technology is concerned, we offer customers more than 15 years of experience. The Vision Sensor LM is the logical continuation of the development of many line scan camera solutions in the field of embedded vision." ∎

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Machine Vision Applications for Battery Production

How Industrial Cameras Are Used to Inspect Lithium-Ion Battery Defects

From smartphones to electric vehicles, lithium-ion batteries can be found everywhere. Increasing reliance on Li-ion batteries, however, requires increasing caution to prevent field accidents which could prove fatal to customers. For this reason, quality assurance through machine vision solutions is critical in the Li-ion battery production process.

While Li-ion batteries have seen a rise in popularity for their numerous advantages, disastrous cases such as exploding smartphones draw attention to their risks at the same time. Throughout the entire manufacturing process, including electrode and assembly processes, the batteries must be scrutinized for defects - just not by humans but by cameras. Vieworks' industrial cameras have demonstrated reliability in battery inspection over the years, with their machine vision solutions successfully installed and currently operating in various Li-ion battery manufacturing plants. A thorough understanding of the qualities and manufacturing process of Li-ion batteries must serve as the foundation of a manufacturer's machine vision solutions, in order to produce solutions optimized precisely for Li-ion battery inspection.

Rise of Lithium-Ion Batteries

Unlike primary cells which cannot be recharged after initial discharge, secondary cells may be reused multiple times. Among these secondary cells Li-ion batteries stand out as a versatile option applicable to diverse fields.

With distinctly high energy density, Li-ion batteries require less weight and volume to carry the same amount of energy as other types of batteries. That they are free from memory effect is another advantage which puts Li-ion batteries ahead of other batteries; Li-ion batteries do not see a loss of charging capacity from memory effect. Moreover, Li-ion batteries are considered non-hazardous waste because they do not contain highly toxic metals such as lead, cadmium, or mer-

cury, setting them apart from hazardous batteries.

For these advantages, Li-ion batteries are currently being adopted by many fields, including smartphones, laptops, ESS (Energy Storage System), and electric cars. The increasing use in these fields is accompanied by an increased demand for and investment in Li-ion batteries.

Importance of Quality Assurance: A Need for Machine Vision Inspection

Nonetheless, a critical drawback of Li-ion batteries is their vulnerability to field accidents. Packing excessive amount of energy beyond capacity can lead to battery explosions as reported by customers. To prevent these accidents, Li-ion battery manufacturers focus on quality assurance by utilizing machine vision solutions in their inspection systems.

Li-ion battery production is divided into three main parts: electrode manufacturing, cell assembly, and formation. Among these processes, machine vision solutions play a key role in electrode manufacturing and cell assembly.

Machine Vision Applications in Electrode Manufacturing

Electrode manufacturing is the process of applying anode and cathode, respectively, to copper and aluminum pole plates. This stage is further broken down into mixing, coating, drying, calendaring, and slitting.

In the mixing process, materials including anode and cathode are mixed to produce slurry, a formula which is then intermittently applied to pole plates in the coating stage. Because copper and aluminum can collect

electrical current - hence the name current collectors - copper and aluminum foils are coated by the slurry. As the tissue-roll-like foils are unwrapped to be coated with the mixture, line scan cameras are used as in web inspection.

In situations like this where the target is moving at a constant rate, line scan cameras are exceptionally efficient. Line scan cameras with 4k and 8k resolution are frequently used in this process. The cameras check not only for foreign matters in coating, but also for whether the coating is spaced uniformly; the foil is intermittently coated to ensure uniform spacing between the coated areas. In addition, all four sides of the coated area are inspected for even margins.

After they have been coated, dried, and calendered the foils are then cut into smaller pieces in the slitting process. The remainder of the manufacturing process after this point is no longer considered web inspection, which is why area scan cameras come into play.

Machine Vision Applications in Cell Assembly

After electrode manufacturing is completed, the cell is assembled according to the cell type. Before entering the packaging stage, a cell may be assembled in two different methods: jelly roll for cylindrical cells and notching and stacking for pouch cells.

Cylindrical cells are assembled through a procedure called jelly roll process. In this jelly roll process, separators are inserted in between the pole plates and placed intersecting in the main carrier plate. Misalignment of the plates in this process leads to battery inefficiency, for which area scan cameras

All images: Vieworks

**Image of industrial cameras utilized in lithium-ion battery production
(Left: Vieworks VC-25MC, Right: Vieworks VL-8K7C)**

must be used. Vieworks' high-performance 5-megapixel VQ-5M cameras reinforce the metrology of the jelly roll process by accurately inspecting the alignment of the plates.

On the contrary, pouch cells are manufactured through the notching and stacking process. In the notching process, the non-coated part of the pole plate is cut and removed. A nonuniform cut surface from this stage results in inefficiency, as does the misalignment in the jelly roll process. Similarly, area scan cameras including VQ-5M and the higher resolution 12-megapixel VC-12M and 25-megapixel VC-25M models inspect the pole plates for uneven surface.

In the stacking process, a separator is inserted between the two electrode plates to prevent short circuit. That the pole plates are correctly aligned is crucial, as misaligned pole plates result in inefficiency and even field accidents. Therefore, utilizing high-performance area scan cameras to inspect the alignment of the pole plates is recommended.

After the jelly roll or notching and stacking process comes the packaging and electrolyte filling process, in which the pole plates are inserted and enclosed in a case filled with elec-

trolyte. An ion-conductive material, electrolyte fills the remaining space within the cell. Area scan cameras are again used to inspect the exterior of the case, whether it be cylindrical, prismatic, or pouch cell. Without such inspection, a dent or scratch may go unnoticed, which may cause a buildup of pressure and possibly damage to the interior of the cell.

Throughout the described manufacturing process, pole plates may demonstrate variations in reflectivity and subsequently in brightness, depending on the degree of bent in highly reflective areas. To enhance the accuracy of metrology in such circumstances, dome type light sources are generally preferred. However, because dome type light sources oftentimes do not provide the required amount of light, low sensitivity is a frequent point of concern. For instance, standard line scan cameras are not sufficient for sequent notching process of medium and large sized cells due to the sensitivity issue. For this reason, Vieworks' high-sensitivity hybrid TDI line scan cameras are particularly suitable candidates for new adoption.

The latest trend in cell assembly inspection is 25-megapixel cameras. The size of

pole plates varies greatly according to the size of the batteries, some being too large to use the standard 5-megapixel or 12-megapixel cameras. To inspect larger batteries, cameras with narrow field of view (FOV) must physically move in order to capture the entire target. On the other hand, 25-megapixel cameras can capture much larger targets even in a fixed position.

Vieworks offers an additional solution in cell assembly inspection by incorporating their expertise in X-ray detector to machine vision technology. Vieworks' automated X-ray inspection (AXI) solution overcomes the traditional difficulties of X-ray inspection. The standard two-dimensional X-ray inspection is ineffective at capturing multiple layered internal battery structure, while three-dimensional CT inspection requires longer exposure time, making it inadequate for mass inspection. To resolve such problems, the company has developed high-sensitivity dynamic detectors and real-time image processing software, offering a near real-time three-dimensional reconstruction solution for battery inspection.

Vieworks offers solutions for all processes of Li-ion battery manufacturing, and they have acquired thorough expertise in battery inspection from their experience with distinguished secondary cell manufacturers in South Korea. ◼

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Improved Remote Control

Expanded Functionality of Camera Remote SDK and Increased Range of Compatible Models

An updated Camera Remote Software Development Kit extends the list of supported cameras to include the Alpha 1 and RX0 II, opening many new opportunities for companies to utilize the industry-leading technology in Sony's cameras for the development of bespoke camera applications to improve their own workflow.

Alpha 1 is particularly suited to content creation and the inspection industry due to its combination of resolution and speed with Ethernet control. RX0 II is ideal for 3D scanning and Photobooth usage, due to its ultra-compact body and high image quality made possible by its 1.0-type image sensor.

The latest update now means that up to 20 camera devices can be connected via USB, with the additional benefits of Ethernet connectivity which enables users to operate system over much greater distances.

Easy Remote Control and Integration

Camera Remote SDK allows users to control Sony's cameras remotely from a computer, from changing the camera settings, to remote shutter release and live view monitoring. With this SDK, software developers can design bespoke applications tailored to business requirements, integrating Sony's equipment for size-critical drone and speed camera systems as well as other medical, education, government, and e-commerce functions.

"Since the launch of the SDK in February 2020, demand has been fantastic and we

have engaged with new B2B partners across the globe to develop some incredibly interesting applications that take full advantage of the advanced capabilities of cameras such as the Alpha 7S III and Alpha 7R IV," said Yasuo Baba, Director Digital Imaging, Sony Europe. "Improving the connectivity options for wired multi-camera solutions is crucial for applications in areas such as e-commerce and 3D scanning and we will continue to evolve our offering to best support the needs of our customers."

"The ability to connect multiple cameras in the same session per machine, will greatly expand our photogrammetry capture rig capabilities," said Craig Mason, Director, Stasis Media. "The support for the RX0 II gives us capacity to perform full-body scans at high quality, in tandem with face capture, all as part of the same workflow. This is a great addition to the Sony toolset and will allow us to make use of Sony's high-quality imaging sensors for rapid, high quality photogrammetry scanning."

In addition to the existing support for Windows 8.1/10, ARM Linux and MacOS,

Version 1.04 of the SDK introduces support for x86 Linux, making integration easy for industry customers traditionally using x86 computers.

Unprecedented Resolution and Speed

The Alpha 1 can capture fast-moving objects. High speed readout from the 50.1-megapixel (approximate effective) full-frame image sensor and a large buffer memory makes it possible to shoot up to 155 full-frame compressed RAW images or 165 full-frame JPEG image at up to 30 frames per second with the electronic shutter while maintaining full AF and AE tracking performance. These features are all possible whilst controlling via Super-Speed USB 10 Gbps or 1000BASE-T Ethernet.

It can maintain focus with high accuracy even for fast moving subjects and automatically adjust exposure.

Mini Powerhouse

The RX0 II measures just 59 x 40.5 x 35 mm and weighs just 132 g, yet it delivers fantastic image quality thanks to its 1.0-type image sensor. ■

«

The ability to connect multiple cameras in the same session per machine greatly expands our photogrammetry capture rig capabilities.»

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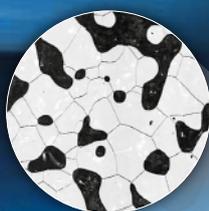# "Our Cameras Cover Any Speed, Resolution, and Cable Length"

Interview with John Ilett, President of Emergent Vision Technologies

With 100 GigE cameras, North American manufacturer Emergent Vision Technologies is one of the high-speed pioneers in machine vision. Last year, the company opened its first European subsidiary in the Swabian town of Kernen. From there, Emergent plans to conquer the European market. Inspect Editor-in-Chief David Löh spoke with John Ilett, President of Emergent, about the company's product strategy, potential areas of application, and the technical underpinnings such high-speed cameras require.

inspect: In your opinion, what are the most important trends of the last one or two years within the machine vision industry?
John Ilett: Virtual reality, sports analytics, and generalized volumetric capture are a business vertical of the Machine Vision industry which continues to grow at a phenomenal rate.

The primary technology at the heart of these systems are high-speed Ethernet cameras and other IoT devices.

AI and Edge Computing technologies are responsible for processing of the masses of video data that are generated by the large camera arrays. However, for convenience and cost savings, cloud processing is often still utilised for point cloud and rendering operations thus taking advantage of large GPU based server farms.

Another important trend is in 3D vision guided robotics where AI and Edge Computing also play a significant role in addressing the demand for more intelligent and faster 3D measurement and guidance systems - this works to the strengths of Emergent's higher speed Ethernet camera technologies.

inspect: In which area of the machine vision industry do you expect the next major developments?
Ilett: The question surely arises what one is to do with the ultra-high-speed video data that are supplied by some Emergent cameras. Often, data is simply stored to RAID arrays for example. Yet, data can also be processed on the fly with an appropriate system design. Forwarding data from the cameras to GPU cards for detailed processing has always been available and the power of such cards is growing rapidly. This is currently possible with Emergent cameras and supplied NICs and can be implemented with Quadro GPU cards from NVidia as well as NVidia Jetson Xavier platforms as examples.

FPGA based cards, such as those from BittWare, are already equipped with interfaces such as SFP+, SFP28, QSFP28 as do the Emergent cameras and work is being done on cards like this to bridge the gap between GPU based and FPGA based processing to allow for suitably powerful edge processing architectures for most ultra-high-speed applications.

inspect: In your opinion, where is the added value for the user of technologies such as artificial intelligence or edge computing?
Ilett: Edge computing is becoming more important as we attempt to speed things up while still needing results in rapid succession. There are different degrees of Edge Computing, of course. One example is to have centralized processing in a local server room, and another is to have more local processing right beside the cameras. The methods already mentioned are there to cover either scenario and the specific architecture chosen is dependent on the application requirements and AI algorithms needed.

inspect: In July 2020 you founded a subsidiary in Germany, your first branch office in Europe. What was the reason for this?
Ilett: Our presence what not as strongly felt within Europe and logically we could not provide optimal service for our customers in this region. In addition, Emergent's growth warranted additional sales team members based on our fast-growing customer base.

inspect: How did the first steps in Germany go?

The Zenith 100 GigE high-speed camera from Emergent Vision Technologies

John Ilett is President of Emergent Vision Technologies.

Ilett: All things considered we are looking at a four times factor sales growth over our first year in this region. Part of this success is tied to the expansion while major product launches and Marketing campaigns are certainly playing a role.

inspect: Which countries are next on the list?
Ilett: Aside from Germany, there are no real standouts but rather a strong mix from many countries within the EMEA region. We are always exploring expansion opportunities but, in the meantime, we are very well equipped to service all countries within EMEA.

inspect: What are the major strengths of your cameras?
Ilett: To be clear, it is much more than just the cameras that Emergent takes responsibility for.

Emergent cameras cover applications of any speed, any resolution, and any cable length. We do this by owning the application requirements and providing logical solutions with top tier applications, technical, and sales support.

We work to integrate enabling technologies for use with Emergent cameras such as servers, switches, RAID technologies, GPU cards, FPGA cards, etc. to minimize the customer's integration effort. Part of this effort goes into host side solutions working with companies like NVidia and BittWare to create 0% CPU footprint for packet related processing leveraging standard features in higher speed OTS NIC cards like RDMA and RoCE.

inspect: In which application areas are the cameras currently primarily used?
Ilett: Virtual reality, sports analytics, and generalized volumetric capture account for about 70 percent of the business with generalized Machine Vision at 30 percent but growing quickly.

inspect: Which current applications really take advantage of the high bandwidth of 100GigE?

Ilett: Higher resolution dictates higher speed to maintain appropriate frame rates and the applications here are vast but can include AOI, Virtual Reality, Sports analytics, Flat Panel Inspection, etc.

inspect: Which application areas do you want to enter next?
Ilett: The intent is to focus on the current key areas and continue to develop and integrate enabling technologies to strengthen our position in the current markets.

inspect: What advantages does the Ethernet interface offer over the competition?
Ilett: The only interface worth mentioning in this discussion is CoaXPress (CXP). Here are the common categories of comparison:

Power Consumption: Some claim that power consumption is better with CXP and this is simply not relevant based on the num-
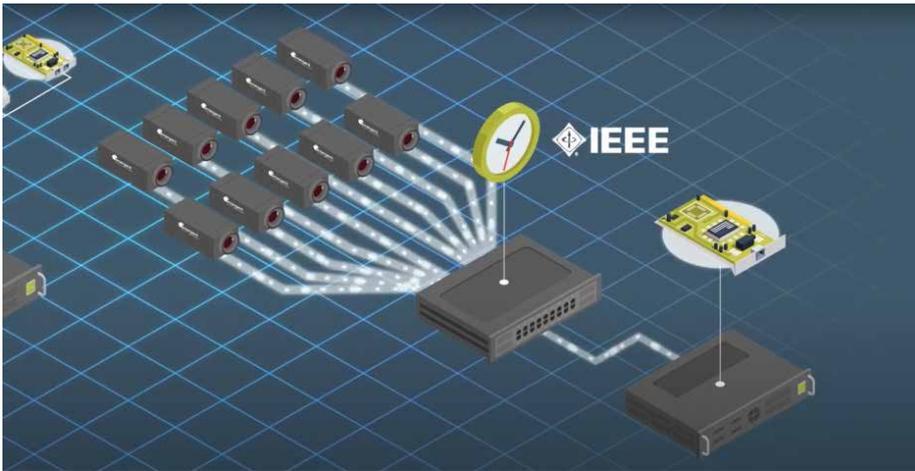
GigE supports multi-camera configurations using a switch.

bers. SFP+, SFP28, QSFP28 technologies are all quite low power as is CXP. CXP is based off the transceiver chip from Microchip who states 0.125W for each channel of 12.5Gbps. This also requires transceivers from the FPGA of the same speed since the Microchip part is simply a cable driver and for this, we must add another 0.125W per channel.

If we take two of these channels (now two coax cables) to equal one 25GigE/SFP28 link, then we see 0.5 W while for a 25Gbps transceiver in the FPGA we see 0.5 W.

For 25GigE, we will add less than 1W for SMF transceiver (up to 10Km), 0.5W for MMF transceiver (up to 70m), or 0.125W for Direct Attach cables (up to 5m).

However, all cameras need an FPGA and an image sensor, and you will see that the cameras using either interface are stating in the area of 10 W, so these power numbers are an extremely small portion of the overall power consumption. So, this comparison is not relevant in the grand scheme of things.

Enter CXP over fiber which simply steals the Ethernet physical layer and now all is equal for power consumption.

Cabling: If we compare CXP based on its Coaxial cable form, then Ethernet SFP cabling supports cable lengths far in excess of CXP (40m vs >10km).

Some argue that single cable for power and data is a benefit, but this argument falls apart if 2 or more CXP channels are needed which calls for further cables for each channel. Consider that hybrid copper/fiber cables are available for SFP technologies to support power within the same sheath. Again, CXP over fiber steals Ethernet physical layer and all is equal for cabling.

Standardization: The IEEE traces its founding to 1884 and since then has formed the basis for virtually all communication we do. And the 802.3 working group traces back to 1973. It is this standard's organization we base our camera technology upon.

GigE Vision has easily won Machine Vision market majority and we simply extend its capabilities with much higher speeds and have also addressed the limited shortcomings in comparison to CXP.

CXP is a standard managed by the JIIA (Japan Industrial Imaging Association) which was founded in 2006. CXP version 1.0 was presented in 2010 based on a handful of interested Machine Vision companies. CXP was developed as a Machine Vision standard with the intent of replacing Cameralink and providing higher speeds, single cable for power and data, and to use over typical co-axial cable. Over the years, higher speeds were required so extra cables were added creating a bulky bundled cable assembly. Longer cable lengths were required as well, which is a limitation of speeds beyond 12.5Gbps which then required bulky and costly fiber adapters.

With a name like CoaXPress, it would seem that such technology limitations were after-thoughts as they all seem to fall out of the use of co-axial cable.

The answer they have is CXP over fiber which no longer provides power over the cable as it was intended and is certainly not co-axial cable any longer but, rather, steals the entire physical layer from Ethernet. Perhaps a name change would make sense to avoid confusion. Remind me again why we needed another standard.

But keep in mind, that while CXP over fiber uses the Ethernet physical layer that it does not use the Ethernet protocols. As such, low cost NICs, switches, PTP, multi-casting, camera multiplexing, redundancy, and all other general network principles remain out of reach for CXP.

Speed: In its current co-axial state, CXP cannot create a single link cable solution like Ethernet SFP28, QSFP28 and beyond. CXP over fiber naturally could since it steals the physical layer from Ethernet. We should note that CXP over fiber is very much in its infancy

and, with the small handful of suppliers driving this that grabber cards, cameras, covering the higher speeds such as 50G and 100G are not expected anytime soon.

Synchronization: Triggering multiple cameras from the CXP card has been considered an advantage over Ethernet technologies. One could argue that this is the strongest point that CXP could stand for. However, for multi-camera systems, employing a low-cost switch and PTP achieves the same goal which also provides benefits such as multi-casting, camera multiplexing, redundancy which easily work to offset the relatively small switch costs. Local hardware triggering is also very common. Consider also that if you are running multiple channels of CXP that it appears that running extra signals in a bundle is not out of the question for its users.

Having said that, cards are available with SFP+, SFP28, and QSFP28 interfaces with front panel trigger inputs that are used to fire small GigE Vision trigger packets up the same cable to eradicate this perceived advantage completely. This seems a much smaller step to take versus developing a whole new standard to address. (dl) ∎

All images: Emergent Vision Technologies

Camera modules with PCI Express

The mvBlueNAOS Matrix Vision uses PCI Express for image transfer. The interface is a standard that is used in all PC systems as well as in embedded processor platforms. This means that the mvBlueNAOS camera modules can be used regardless of the platform. A GenICam -compatible software support ensures compatibility with existing machine vision programs, and thus the platform independence. First models with Sony Pregius and Pregius S sensors offer resolutions from 1.6MP to 24.6MP and are available immediately. The PCIe x4 interface allows transfer rates of up to 1.6 GB / s. and thus offers enough space for higher bit depths, simultaneous image preprocessing and future sensors with higher frame rates.

www.matrix-vision.com

Thin Mini-ITX mainboard with ten cores

With the PH12CMI, ICP Germany is bringing another mainboard in the Thin Mini-ITX form factor onto the market in addition to the PH 11CMI, which supports the tenth generation of Intel Core processors. The flat mainboard has a size of 170 x 170 mm and comes to a height of only / only 20 mm. The PH12CMI is with the Intel - Q470E - equipped chipset and an LGA - 1200 - equipped base. The mainboard supports Intel - processors ten th generation with 10 cores and 35-Watt Thermal Design Power and processors with 8 cores and 65-Watt Thermal Design Power. The two DDR4 SO-DIMM sockets can be equipped with up to 64GB non-ECC memory with a maximum clock frequency of up to 2933 MHz. The integrated graphics unit offers triple display support with a maximum resolution of 4K. An HDMI port with a resolution of up to 4096x2160 pixels, a display port with a maximum of 4096x2304 pixels and an LVDS connection with a full HD 1920x1200 pixel resolution are available for connecting displays.

www. icp-deutschland.de

Embedded vision platform with SoM

Hema integrates the new Xilinx Edge-AI SoMs of the Kria series into its embedded vision platform. With the associated modular system, customers can configure individual electronics and receive a near-series prototype within just six weeks.

The platform has so far been available with System on Modules from Enclustra and Xilinx and thus enables flexible selection and scaling of performance. With the recently presented Xilinx Kria SoMs , Hema is now expanding its portfolio with additional modules that have been specially designed for use in applications such as Smart Cameras, Embedded Vision, Machine Vision and Smart City. First SoM was Xilinx Kria K26 integrated.
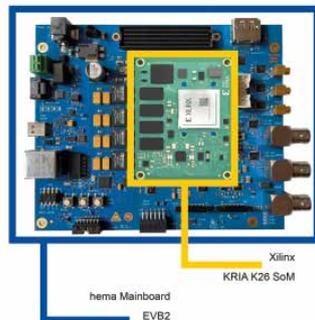
www.hema.de

Latest IP65 Embedded Box PCs in customer-specific design

With the completely IP65 protected, waterproof and dust-proof industrial computers of the T box -C series, Taicenn meets the requirements of a typical outdoor industrial application. This includes, for example, protection against condensation, steam or direct rain and other harsh environmental conditions.

A cable entry module enables the IO interfaces to be sealed when standard cables are used, without costly cable assembly.

To further meet the application needs of customers, the company Technology offers project-related adjustments in terms of, for example, design, size, operating environment, performance configuration, module functions, assembly methods or testing and certification.

www.taicenn.de

AI platform for GPU edge computing

Acceed´s new industrial embedded computers of the DLAP-4000 series are characterized by a PEG slot (PCI Express for Graphics). This is a PCIe x16 slot that offers a higher power supply directly via the slot. PCIe cards in standard slots may consume a maximum of 25 watts, low-profile cards even only 10 watts. A PEG slot supplies up to 75 watts, additional power can be obtained from the power supply unit. For edge computing tasks, such as the intelligent control and monitoring of processes, machines and systems with large amounts of data and complex algorithms, powerful graphics processors such as the Quadro models from Nvidia are a must.

The models of the DLAP-4000 series offer a multitude of combinations with the high-performance cards from Nvidia up to the RTX 8000.

www.acceed.com
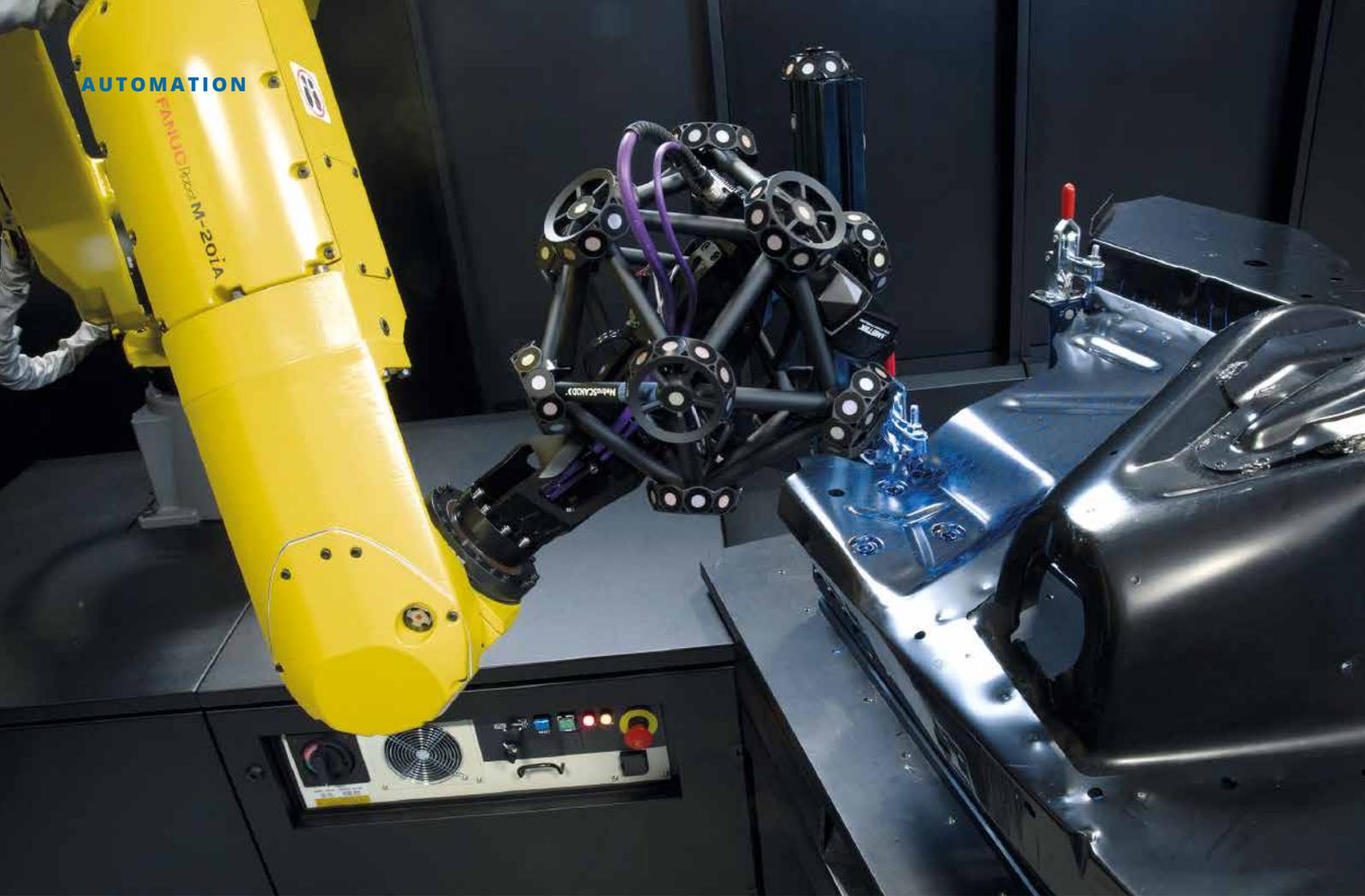
Improving Man

How Robots Complete Humans and Enhance Their Work

When comparing handheld instruments with automated quality control systems, a closer look reveals the automation benefits for manufacturing companies based on their specific requirements.

Few articles compare handheld instruments with automated systems. Thus, this paper aims to address this lack by comparing manual measuring tools, such as handheld 3D scanners and measuring arms, and automated measuring systems, such as 3D scanners mounted on robots. It also intends to answer the following questions:

- Since companies value their human workers, what factors will most impact their preference for one system more than another?
- Which system should be privileged if the company also values repeatability?
- Which system should be prioritized if the quality control process needs to be improved with better decision-making based on more data and statistical analysis?

Technical Challenge: Performing Consecutive Measurements

What inspection results would a human get when measuring 2D entities and surface points several times on a traditional measuring arm? What would be the difference between the highest and lowest measurements (average range)? How long would it take to program the instrument and perform the inspection? We did the exercise (Fig. 1).

Because the human is human, it is possible that the orientation of the handheld sensor will not be maintained perfectly from one part to another. It is also possible that the measurement position will not be exactly the same on each geometric feature. Moreover, with probing technology, it is possible that the human will not exert the same pressure from one measurement to another, which, on composite or sheet metal part, could cause a certain bending that could slightly deform the part. Therefore, it is possible that measurements taken with handheld devices may differ from part to part, causing repeatability issues that could lead to deviations and false results.

Solving Repeatability Issues with Robotic Systems

What inspection results would be obtained if our previous 2D entities and surface points were measured with a 3D scanner mounted on a robot? Would we see an improvement in repeatability? Could we accelerate the programming and measuring times? Again, we conducted a test (Fig. 2):

The obtained results demonstrate what we could have presumed: because robots are known for their near-perfect repetition, the robot maintains its position and orientation from one measurement to another, offering better repeatability. Moreover, since scanning was favored over probing, a larger amount of data was collected rather than one-off measurement points, eliminating the problem of pressure being exerted on the part.

Considering that robotics increases repeatability, it is logical to think that a manufacturing company that values this attribute first and foremost would benefit from upgrading its handheld devices to an auto-

Traditional measuring arm
Programing time: none
Measuring time: 25 minutes

	Average range
2D entities	0,104 mm
Surface points	0,213 mm

Fig. 1: Traditional measuring arm

3D Scanning CMM
Programing time: 2.5 hours
Measuring time: 4 minutes

	Average range
2D entities	0,065 mm
Surface points	0,027 mm

Fig. 2: 3D Scanning CMM

mated system. Not only would the robot provide more repeatable results, but also it would address the shortage of skilled manpower. Indeed, automated quality control solutions help with the lack of qualified technicians by taking over non-value-added tasks, such as moving a 3D scanner over a part. In addition, with its increased data input, 3D scanning provides quality control with more information, supporting better decision-making.

Nevertheless, in order for this shift to robotization to be justified, it must also be accessible to all. Before getting on board the automation adventure it is essential for the manufacturing company to ensure that their chosen technology is simple and easy to operate and program without requiring excessive training.

Conditions: Simplicity and Accessibility

Not everyone has expertise in robotics. For this reason, it is imperative that robotized measuring systems be accessible to all, regardless of their level of competence or experience. Systems must enable users of all levels to easily and quickly program robot paths and optimize the robot's line of sight.

Due to their operational simplicity and off-line programming capacity, both collaborative robots and digital twin environments lead to robotic democratization. Their goal is to make

robotics less intimidating and less complicated.

Collaborative Robots

Collaborative robots (cobots) are a form of robotic automation built to work safely alongside human workers in a shared, collaborative workspace. In most applications, a collaborative robot is responsible for repetitive tasks, leaving more complex and thought-intensive tasks to human workers. In addition to being easy to program and deploy, cobots are designed to complement the intelligence and problem-solving skills of human workers.

Compared to traditional industrial robots, which are mainly located in a dedicated room and isolated from human contact, collaborative robots are designed to work with and close to humans. Most of them are equipped with a series of sensors to avoid collisions with humans, as well as safety protocols to shut down if any form of unplanned contact occurs. Therefore, their ease of installation, programming, and use make them very attractive to anyone willing to try their first robotic project.

Digital Twins

Digital twins ensure higher deployment success because they allow the entire process—input, process, output—to be simulated. These powerful tools are used to do the following: 1) simulate all the parts that an

automated system can accept (input), 2) validate the cycle time and ensure that all entities to be measured are reachable (process), and 3) produce results (output) and validate that the inspection report contains all of the data required to make the desired decisions.

Because the digital twin presents a fair and accurate representation of reality, it can generate, automatically or interactively, optimized robot paths for specific 3D scanners in order to create a scanning experience that benefits all users and not just experts. Because of this, it

All images: Ametek

Fig. 4: CMM types: articulated measuring arms – traditional CMMs – robot-guided 3D CMM scanners

is almost impossible to perform a poor acquisition.

Benefits of Opting for Intuitive Automated Measuring Solutions

1. The Value of Human Workers in Complex and Thought-Intensive Tasks

Skilled, experienced, and productive employees are a rare find. When we find them, we want to keep them and make sure that they feel fulfilled in their job. One way is to relocate them from repetitive tasks for which their contribution has no added value to high-value tasks, such as robotic programming and data analysis, which are now fully accessible and democratized. More complex and thought-intensive tasks can motivate employees to develop their skills even further, which will create value for the organization and support retention.

2. Better Decision-Making Based on Better Data Analysis

We measured a 1969 Ford Mustang dash panel on both a traditional CMM and a robot-mounted optical CMM. Although the results are not surprising, the measuring time difference is stark. Including similar loading and unloading times, it took 30 minutes on the traditional CMM, while measuring the same part on the 3D scanning CMM required only four minutes (these two measuring periods exclude the programming time). So, during this 30-minute period, not only could the company measure about seven more parts with a more repeatable system, but also it could base its decision-making on more data rather than on a single measurement that could always be influenced by human handling error. Better data quality and quantity lead to better decision-making. Better data analysis enables users to measure specific entities over which they have less control in order to improve part quality (Fig. 3).

3. Better Quality Control

A 30-minute measuring time with a robot-mounted optical CMM could be used to inspect 100 percent of the dimensions rather than measuring only 10 percent of the features on the traditional CMM during the same period. Quality managers feel more confident with complete inspections. After all, quality control based on 100 percent of the dimensions enables them to improve the quality control process in order to build parts of better quality.

Added Value for Manufacturing Companies

Changing from probing to scanning technology allows users to measure specific features and to acquire a multitude of data essential for better data analysis. Moreover, upgrading from a manual instrument managed by a human to an automated system operated by a robot increases repeatability. Both of these advances have an impact on productivity, efficiency, and product quality. Ultimately, they contribute to producing parts of better quality.

Nevertheless, it's important to keep in mind that any change in the quality control process must be accessible to all, as well as simple and easy to implement. Collaborative robots and digital twins play an important role in making automatization comfortable for non-robotic experts by facilitating robot programming and helping humans feel more secure in the presence of robots.

This way, human resources can focus on value-added tasks that require their full capability and potential. Not only does this motivate employees, but also it creates value for the organization. Human workers are then seen as an added value and a key element driving the company's efficiency and productivity. ∎
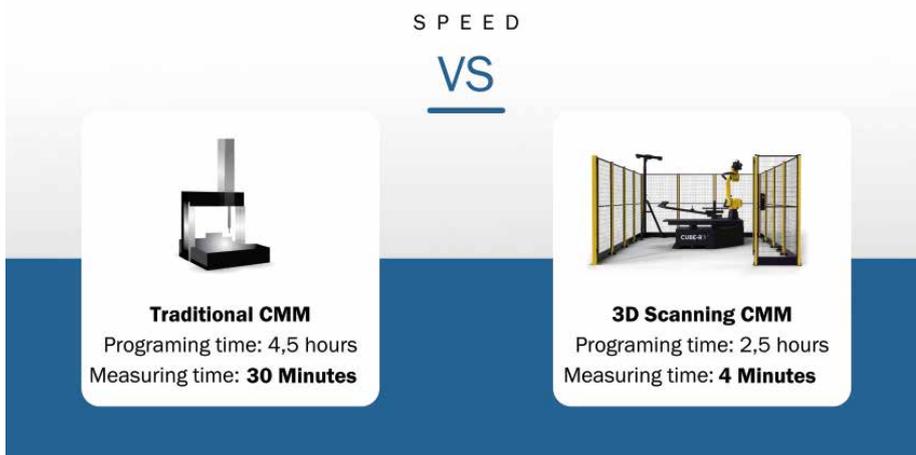

Fig. 3: When comparing the speeds, the robotized coordinate measuring machine wins against the traditional one with ease.

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High-speed module for modular 3D sensor

A sensor speed of up to 26 kHz, a resolution rate of 4,096 measuring points per profile and a data interface for 3D sensors according to the latest standard: the cx4090HS is the first sensor module of the new C6 series from Automation Technology, which complements the modular 3D sensor concept. With a factor of 1.8, the module is almost twice as fast as the previous 4K models of the C5 and MCS series, so that the measurement options in the 3D area reach a completely new level.

Applications such as wood inspections, electronics inspections, road surface inspections or tire geometry inspections, for which both a large measuring width and a high resolution are required, benefit from the new high-speed sensor module. Since the cx4090HS can scan objects up to a width of 2 meters, it also offers a solution for applications with a large measuring width.

www.automation-technology.de

Photoelectric barriers and buttons with IO-Link

The robust miniature sensors of the series O-21 miniature from disoric are only 28 mm x 8 mm x 14 mm in size. They quickly and reliably recognize small objects, positions and small differences in height, practically regardless of the surface. The light barriers and light switches with red light LEDs enable reliable object detection with a high functional reserve. They are preferably used where there is little space available.

The O-21 miniature series with IO-Link is now available in four different versions. The OH21 photoelectric proximity switch with background suppression detects even the smallest differences in height. The OR21 retro-reflective sensor is suitable for use in extremely cramped installation situations (e.g. in a label dispenser). The OT21 photoelectric proximity switch uses a large light spot to reliably hide gaps and holes during object detection. The OS21 / OE21 one-way light barrier pair is space-saving according to the manufacturer and can be integrated into a guide rail.

www.di-soric.com

Smart 3D camera for robot applications

Matrix Vision and Roboception are entering into a long-term partnership in order to offer user-friendly products for the 3D image processing market and in particular for robot users based on their image processing and 3D competence. The 3D camera family was developed for stationary and mobile robot applications such as bin picking or the navigation of driverless transport systems and promises particularly easy operation.

Using the on-board processor, the rc_visard can process the camera data directly and pass on task-relevant information, such as gripping points, directly to the robot application, mostly without the need for an external computer. This reduces system costs and the risk of the application failing.

The on-board software package makes it particularly easy to use the rc_visard as a 3D stereo sensor, for example for efficient and reliable object recognition, indoor navigation or gripping planning. For specific tasks, the optional rc_reason software suite offers intelligent tools with which, among other things, pick-and-drop applications can be implemented without training individual objects.

www.matrix-vision.de

High-performance battery pack for demanding applications

With the new BP-LFP-2725, Bicker presents an intrinsically safe 10-year battery pack for emergency power supply and DC UPS systems. The lithium iron phosphate energy storage device with integrated battery management system (BMS) is designed for applications that place the highest demands on quality, safety and reliability. The compact BP-LFP-2725 with high energy density is designed for more than 6000 full cycles and is therefore ideally suited for use in particularly demanding applications in the industrial environment and medical technology. The battery pack is tested and certified according to IEC62133-2 and UN38.3.

www.bicker.de

A DC / DC UPS for industrial computers

Efco has presented the bridging power supply DC UPS. Depending on the version, the internal energy storage is designed to supply a small IoT edge gateway for several seconds - or a powerful image processing computer including cameras supplied via PoE for a quarter of an hour. Thanks to modern construction details copied from the leading electric vehicles, an extended temperature range of -50 ... + 75 ° C can be realized.

The storage cells suitable for the respective task are used. This consideration - in addition to the energy requirement - also includes the operating temperature, the available space or the maintenance cycles of the higher-level machine or system. Accordingly, super caps are used, a wide variety of accumulators, from Li to NiMH to lead gel, or a combination of different energy storage devices. This is useful, for example, if both short-term fluctuations have to be compensated for, but also longer phases without a power supply, as is the case, for example, on mobile machines.

www.efcotec.de

Smart scanning for process monitoring

Scanlab introduces the Scanbcube IV, the first member of this product family to have optional readback functions and thus an important component for process monitoring.

The housing design is appealing and a functional component of thermal management. With suitable tunings, the new scan head can be configured for different customer requirements. The system linearity, which is 30 percent better than its predecessor, the SCANcube III, simplifies calibration and enables more precise machining results.

www.scanlab.de

The company Ecomark specializes, among other things, in labeling food directly on the tray via laser marking.

Why Pack When You Can Laser?

3D Sensors in Food Branding Application

Instead of printing the barcode on the packaging, it can also be lasered directly onto the skin of fruit or vegetables. This saves on packaging costs and protects the environment. But to ensure that the peel is not damaged in the process, the focus of the laser must be precise, despite the fact that the individual fruits are always different sizes.
A 3D sensor from a company in northern Germany helps with this.

The company Ecomark specializes, among other things, in labeling food directly on the tray via laser marking. On the one hand, to produce less plastic and packaging in the future, but on the other hand also to provide an effective process under the aspect of sustainability and environmental friendliness, which at the same time is also demonstrably economical.

However, food branding required a great deal of technical know-how right from the start, as there were several important details to consider when labeling food.

Technical Requirements for the 3D Application for Food Branding
To be able to position the marking laser individually for each product and thus guarantee a one hundred percent hit rate for the marking of the groceries, an individual application was required. With the help of a 3D sensor, this application had to be able to determine the position of the fruit and vegetables on the conveyor belt. The challenge was to develop a 3D scan solution that is precise, fast and also sends reliable data to the marking laser despite changing measurement widths and different positions of the fruit and vegetables. Automation Technology's solution: a product from the C5-2040CS sensor family. The 2040 sensors combine speed and accuracy, and also allow a measuring width of up to one meter with a resolution of 2,048 measuring points. Furthermore, they are almost mainte-

nance-free and require hardly any support, as they are already factory-calibrated and can be easily integrated into any existing system via Plug&Play using their GigE Vision interface without much installation effort.
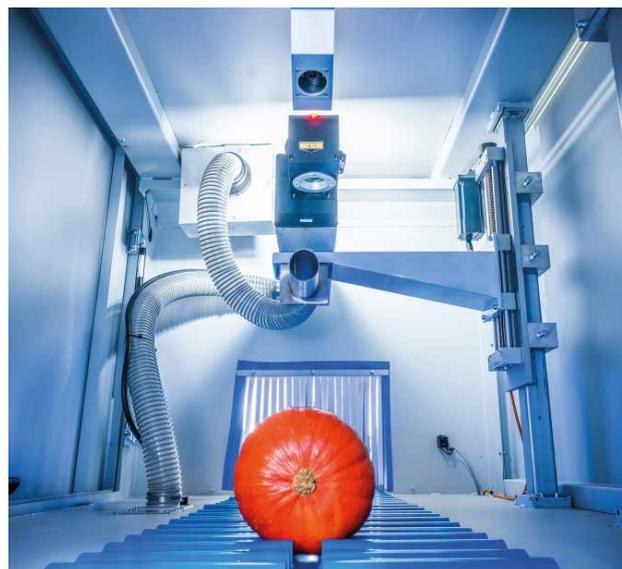
"Ecomark is a perfect example of the unique diversity of AT's 300+ sensor variants. Based on the customer's technical data, we were

«

The solution enables the positioning of the marking laser individually for each product and thus guarantees a one hundred percent hit rate for the marking of the groceries.»

Laser marking eliminates the need for packaging.

Ecomark's food branding machine from the inside

able to deliver the right 3D sensor to meet their exact requirements," explains Michael Wandelt, CEO of Automation Technology.

Food Branding Is Significantly More Economical than Packaging

However, in addition to the convincing technology of the food branding application, the focus is also on the cost-effectiveness of this process optimization. "We are very optimistic that the trend of food labeling directly on the tray will become established in the future. Ultimately, this method is significantly cheaper than previous plastic solutions, as packaging costs are eliminated. We only incurred costs at the beginning of production due to the purchase of the labeling system, further follow-up costs are very low," says Richard Neuhoff, CEO of Ecomark.

Even before the company developed machines for food branding, the company was already specialized in laser machines for marking any material. Due to years of expertise in this area, the idea of so-called natural branding was born in 2018, with which the company was able to attract global attention. Ecomark is now one of the largest international providers of food and natural branding. In general, their labeling machine marks up to 100,000 fruit products per hour, depending on the thickness of the tray and the nature of the variety. "Each fruit and vegetable product has a different size and, of course, a different peel, so we always have to be careful to find the best compromise between the visibility of the marking and the shelf life of the product. If the laser were set incorrectly, for example, the peel would be destroyed in the process,

so you have to know very well what you are doing," Neuhoff continues.

3D Application with Future

For the application that Ecomark has developed with the AT sensors, it is irrelevant whether a kiwi or a cucumber is lying on the conveyor belt. The 3D sensor scans the fruit and vegetables flexibly and creates a 3D point cloud for each product within milliseconds, according to which the marking laser is then aligned. To present date, AT has already supplied 15 C5-2040CS sensors for the food branding application, with further sensors for other industries in the pipeline, as they have been in continuous use since first being integrated into the labeling system when flexibility and productivity are required. ■
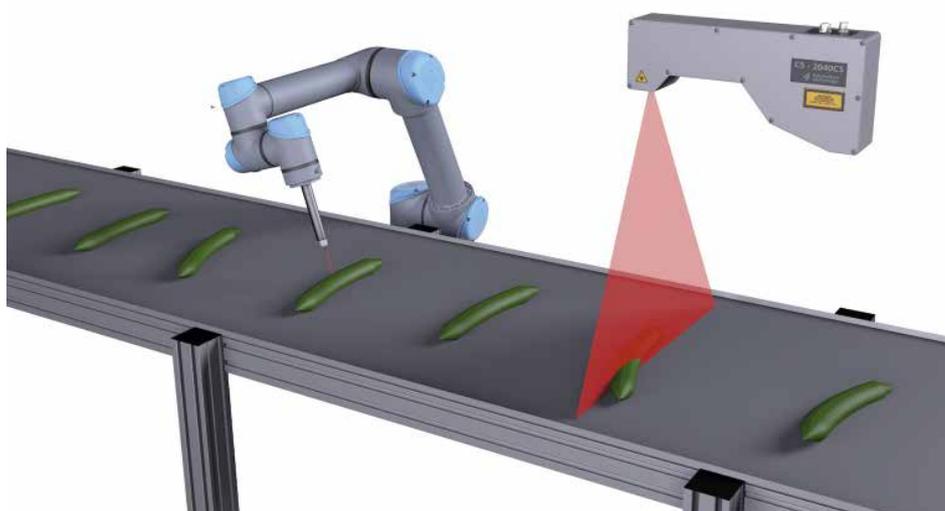
The 3D sensor scans the vegetables and creates a 3D point cloud for each product within milliseconds.

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All images: Automation Technology

Image: FH Technikum Wien

Safe Workspace Monitoring in Scientific Research

Time of Flight Technology Enables Safe Research Activities

The Digital Factory of the advanced technical college Technikum Wien is a pilot factory where students implement typical Industry 4.0 scenarios. The innovative technologies and robotic systems of the factory now also include a safety certified ToF sensor that enables safe research activities within the field of virtual workspace monitoring.

The Spotguard solution from Austrian manufacturer Tofmotion consists of hard- and software that reliably detects objects entering a danger zone or movement zone. In such a case, an electronic signal is automatically sent to the machine controller and an action is initiated accordingly. "As an innovation driver, we offer a product that is far superior to conventional safety sensors," Dr. Christian N. Neufeld, CEO of Tofmotion, points out. "We give eyes to machines and enable three-dimensional

perception for a successful human robot collaboration." Spotguard performs defined safety tasks and reliably protects humans and machines against collisions. The user does not only benefit from superior functionality and efficiency but also from significant cost advantages.

Tight Cooperation Between Industry and Applied Research

Spotguard has already proven itself in numerous industrial applications. Therefore, this innovative concept is also of interest for academic research. Amongst others, Tofmotion cooperates with Technikum Wien, where the solution was put into operation in summer 2020. "It was prompted by the bachelor thesis of a student in the field of mechatronics/robotics," says MSc Clemens Ambros, Junior Researcher/Lecturer in the field of Digital Manufacturing, Automation & Robotics, at the advanced technical college Technikum Wien. "The scientific work checked whether virtual camera-based safety systems are suitable to safeguard the workspace of a Kuka robot. A typical application

scenario with Spotguard was setup for the practical tests."

One mission of the Technikum Digital Factory is to make academic projects like this one possible. The research facility of the competence field Digital Manufacturing, Automation & Robotics hosts a heterogenous system landscape consisting of more than 20 different industrial robots of variable manufacturers and functionalities. Students benefit from this infrastructure by attending interactive courses and scientific research with different specializations. A cooperation that goes far beyond mere product sponsoring is a key success factor: The development and implementation of projects always take place jointly and in close coordination.

Reliable Workplace Safeguarding

Tofmotion supported the installation and integration of Spotguard into the control system of the respective robot. Moreover, two employees of the Technikum Digital Factory have been trained on product and GUI handling. This included also hands-on training on parameter settings, physical frame condi-

« This is a good application for changing lightning conditions that allows a clear definition of working areas.»

The installation of the camera about five meters above the ground allows a holistic safeguarding of the workspace and the protection of Technikum Digital Factory's employees.

tions and setup of different safety scenarios within the solution's GUI. The system calibration regarding the environment has also been carried out by Tofmotion.

"Spotguard is currently integrated into a robot-machining-application. It is a robot workstation for subtractive machining activities," Dr. Christian N. Neufeld explains. The installation of the camera five meter above the ground enables a holistic safeguarding of the workspace and the protection of the Technikum Digital Factory employees. "To make this possible, the only access to the robot station was overlaid with digital 3D-warning and danger zones within the Spotguard GUI." According to the position of a person within the respective zones, the system triggers a "light" stop (category 2) or an emergency stop (category 1) of the robot.

Less Effort and Much More Benefit

The established system of Kuka robot and Spotguard contributes to scientific research activities carried out as a part of the „Sicherheit in intelligenten Produktionsumgebungen – SIP4.0" project funded by the City of Vienna. The employees analyze complex industrial situations according to safety of machinery and IT security and how they influence each other. "We had already an older camera-based safety system in operation that did not meet our expectations," Clemens Ambros explains. "In contrast to this solution, Spotguard proves to be a good application in changing lightning conditions and allows a clear definition of working areas. The new solution is the first product available on the market that can reliably safeguard our employees within this scenario."

Virtual monitoring of workspaces in industrial plants enables machine and work safety to be achieved at a high level. At the same time, the required effort and equipment decrease significantly. Additionally, the system can be easily adapted to changing environments and requirements: warning zones and danger zones can be simply changed without adjusting the mechanical installation. "In conclusion, Spotguard enables us to conduct application-oriented research in the field of workspace monitoring, from which industrial companies will profit from," says Clemens Ambros. A win-win-situation for industry and research that still holds a lot of potential for the future. ∎

Spotguard is a safety certified solution consisting of hard- and software that has already proven itself in numerous industrial applications.

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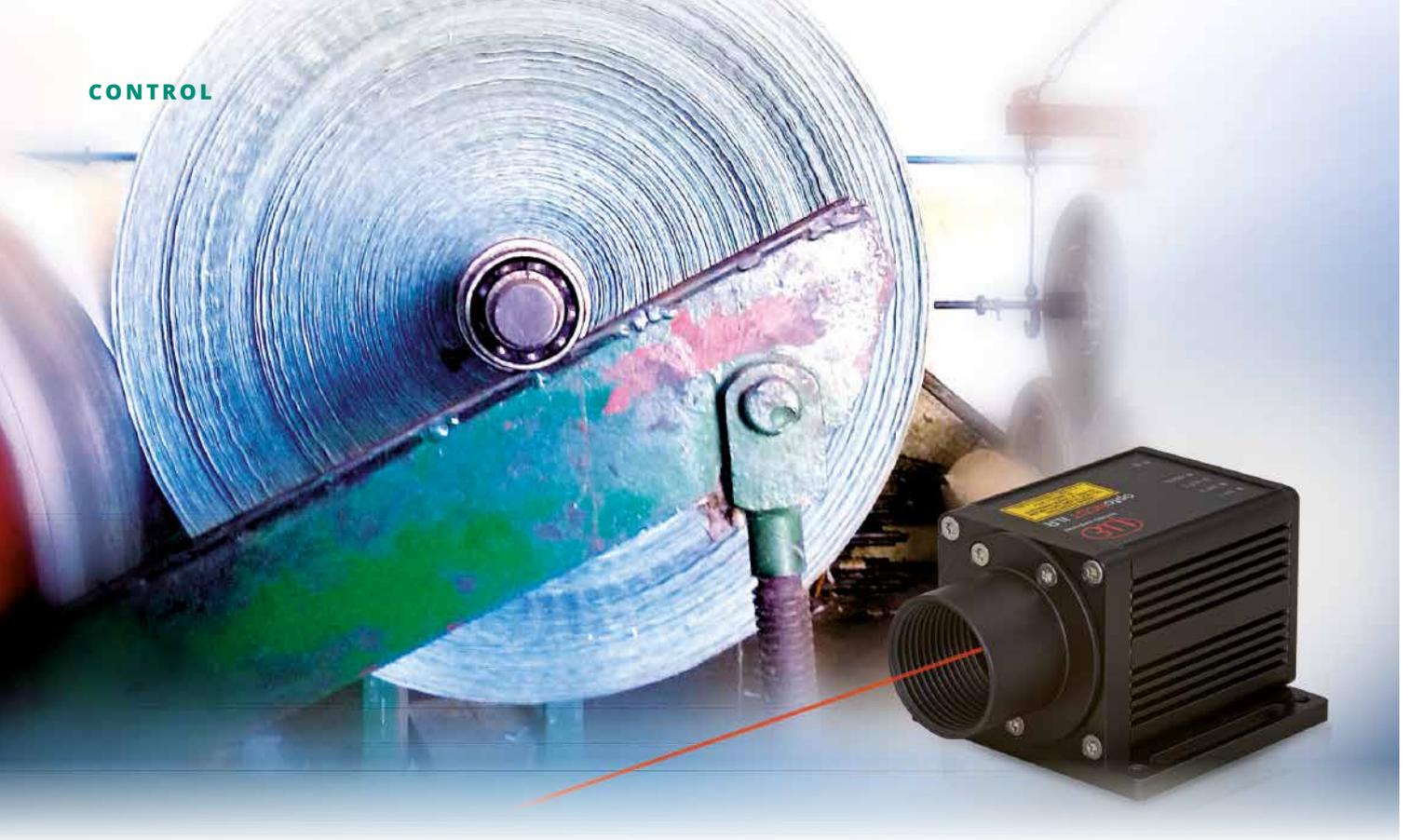
Keep Your Distance!

Laser Distance Sensors for Large Measuring Ranges

Robust laser distance sensors designed for large measuring ranges are used in industrial environments and offer different measuring modes for optimal exposure on demanding surfaces. The sensors provide precise measurement results with high signal quality independent of the surface, whether it is on metals, plastics, paper, or textiles.

In factory and plant automation, large distances between the sensor and the measuring object must be monitored. Micro-Epsilon has developed the OptoNCDT ILR2250 laser distance sensor for these measurement tasks. The sensor covers measuring ranges up to 100 m without a reflector. When using a reflector, the measuring range can be extended up to 150 m. Their robust aluminum die-cast housing protects the sensor against harsh environmental conditions. The integrated optical interference filters provide the ILR2250 sensor with very good ambient light suppression. Therefore, measurements are also possible in outdoor areas, such as for monitoring the travel paths of crane axes or drone-based distance measurements. Their innovative technology enables demanding

measurements on different surfaces, such as paper or plastics, as well as metals and textiles.These advantages make the OptoNCDT ILR2250 ideally suited to many industries such as the steel industry, and transport, logistics and conveyor technology.

The Measuring Principle
TheOptoNCDT ILR2250 works with a red semiconductor laser of a wavelength of 655 nm and is assigned to laser class 2. Its measuring principle is based on the phase comparison measurement. The sensor emits high-frequency, modulated laser light. The light that is returned to the sensor is phase-shifted due to the reflection at the measuring target and is compared to the reference signal. The value of the phase displacement enables the determination of the distance with high accuracy. The measurement is triggered either by a control unit, a PC, a trigger signal or the auto start function.

Put in the Right Light
The laser distance sensor from Micro-Epsilon offers outstanding signal stability on numerous surfaces, which enables measurement results down to millimeter accuracy. This innovative sensor technology is almost independent of the material on objects with a reflectivity from 6 to 100 percent. Therefore, it's suitable for versatile applications on different surfaces.

Presets are available for various applications, providing a predefined configuration depending on the material or reflection. The Auto measurement mode is used for dark or weakly reflecting measuring objects. It provides fast, automatic exposure control even on dark, reflective, and distant objects. This measurement mode optimizes the measurement frequency of the sensor, depending on the signal quality, and therefore provides the best results even in difficult conditions. The "Fast" mode is suitable for dynamic measurements on moving objects and fast distance jumps with movements of up to 1.6 m/s. Furthermore, users can select the "Accurate" mode for high accuracy and tolerance with distance changes, or the "Precise" mode for highest accuracy on well reflecting measuring objects. The sensor then measures at 20 Hz.

Filling Level Measurement in Silos
For smooth production and logistics processes, precise quantity measurements at storage locations for bulk goods or plastic granulates, for example, is a decisive factor. In order to avoid production downtime due to missing material, the levels of the storage silos must be reliably and automatically detected. The OptoNCDT ILR2250 sensors are used for filling level measurement. They are mounted on the top of the silo and measure continuously to the bottom of the silo. These laser distance sensors thus detect the dis-

Continuous detection of the coil diameter is necessary in order to monitor the uncoiling process precisely and to determine the changeover time of the coil at an early stage. OptoNCDT ILR2250-100 laser distance sensors from Micro-Epsilon perform this task.
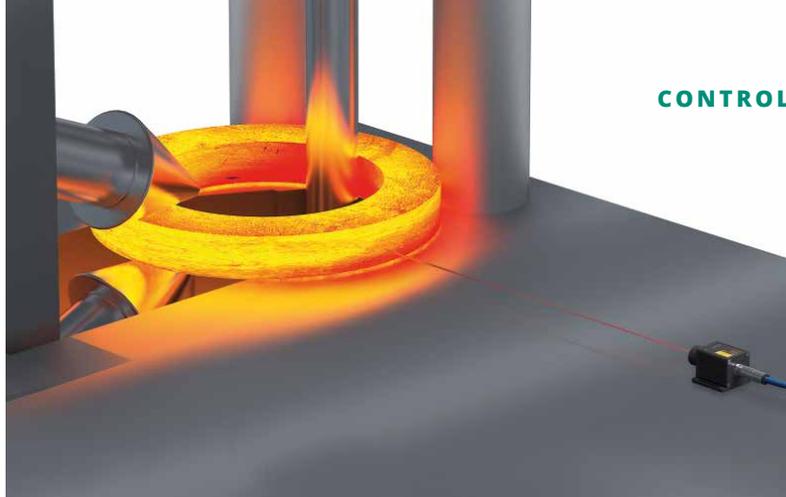
OptoNCDT ILR2250-100 laser distance sensors from Micro-Epsilon are used for measurements on seamless rolled rings. They operate on the phase comparison method, which provides reliable results even on red-hot glowing measuring objects.

tance to the bulk material or granulate. When the silo is emptied, the distance increases, allowing a conclusion to be drawn about the filling quantity, which in turn is output in real time via a level indicator. The generated measurement values are then output directly to the production control system in real time via digital or analog interfaces. The exact fill level, the residual quantity and the volume of the granulate to be filled can now be calculated automatically and passed on to the control room. Time-of-flight laser sensors from Micro-Epsilon ensure continuous production operation, optimum filling of the silos as well as an early warning if the filling level falls below a defined level. These sensors prevent production downtime due to missing material and reduce costs significantly. Simple retrofitting of the time-of-flight laser sensor on existing silos is possible at any time. An additional compressed air cleaning system for very dusty environments is available.

Precise Acquisition of Coil Diameters

Steel strip coils are mainly used in the processing industry, such as the automotive industry to transport wide flat products made of metal or alloys. Large dimensions of around 1.8 m in diameter and the enormous weight of the coil are still challenging for manufacturers. In order to be able to process the material further, the coils must be unwound. For this purpose, continuous detection of the diameter is necessary in order to monitor the uncoiling process precisely and to determine the changeover time of the coil at an early stage.

OptoNCDT ILR2250-100 laser distance sensors from Micro-Epsilon measure the distance to the coil. For this measurement task, the sensor is mounted at a distance of 0.2 m to 10 m aligned to the radius of the coil. It continuously measures the distance to the coil. Unwinding the coil continuously reduces the diameter. Consequently, the distance between coil and sensor increases. The sensor reliably detects this change in distance and transmits it as a measurement value to the control system involved in the

production process. Compared to conventional estimated calculations based on the rotation of the coiler or strip length measurements using mechanical wheels, this method allows precise and wear-free control of the production process.

Thanks to the innovative measurement modes, the sensor provides reliable measurement values even with different alloys and surfaces. With its large measuring ranges, the measurement can be carried out from a safe distance to the coil, which means that the sensor can also be used in harsh environments.

Diameter Monitoring on Seamless Rolled Rings

In ring rolling mills, metals such as stainless steel or titanium are rolled seamlessly into large rings for use at temperatures of up to 1,100°C. For this purpose the red-hot blank is placed in a ring rolling mill. The diameter of the ring increases continuously due to the rolling process. As only minimal tolerances are permitted, the rolling process must be continuously monitored and the diameter must be measured precisely. Conventional sensors that are mounted close to the measuring object cannot withstand the extremely high temperatures, flaking scale and steam. Therefore, measurements from a large distance are necessary.

OptoNCDT ILR2250-100 laser distance sensors from Micro-Epsilon are used for this measurement task. They operate on the phase comparison method, which provides reliable results even on red-hot glowing measuring objects. The sensor is mounted at a safe distance and precisely measures the distance to the rolled material during rolling. As the diameter of the ring increases steadily, the distance to the sensor decreases at the same time. The OptoNCDT ILR2250 sensor detects this difference reliably and with millimeter accuracy. The measurement values are transmitted directly to the production control system via the digital interface. Now the diameter can be calculated as well as the remaining rolling path, which is comprised of the actual volume and the resulting process-

ing steps. The results are then transmitted to the control room for visualization.

Laser distance sensors from Micro-Epsilon enable automatic process monitoring with reliable detection of the diameter change during the production process. The excellent linearity in combination with the high resolution makes the sensor ideal for measurement tasks in rolling mills. In addition, its compact design enables simple and fast integration into existing systems.

Conclusion

The OptoNCDT ILR2250 laser distance sensors use the phase comparison method and detect measuring objects at distances of 0.05 m up to 150 m with maximum signal stability. This is achieved with a linearity of ±1 mm and a resolution of 0.1 mm. Thanks to their high accuracy and robustness, the laser distance sensors from Micro-Epsilon are designed for precise distance measurements in industrial environments. Models with integrated heating are available for outdoor use. The innovative sensors detect the distance to remote objects. Depending on the distance and accuracy requirements, the measurements can be carried out with or without reflector film. The integrated Auto measurement mode enables reliable measurements even on dark, partly reflecting and remote measuring objects. Therefore, the ILR2250 sensors can be used for distance measurements on numerous surfaces. Simple and fast alignment of the sensor is made possible by the integrated mounting plate with four threaded pins. Due to their properties, the sensors are used in logistics and automation technology, the metals industry and production monitoring. ∎

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Crystal Clear

Alignment System with Industrial Machine Vision Improves Glass Packaging Quality Control

Glass is a variable packaging material that imposes challenges on the inspection process, some of which are solved by a fully automatic alignment system that combines isolation, detection of the alignment and reorientation into a single machine.

In the food sector, glass is a very important and highly versatile type of packaging. As a packaging material, glassware is safe, preserves the flavours of its contents and is also environmentally friendly. However, glass has a number of properties that impose some challenges when it comes to quality control. And if these quality checks are carried out in the food sector, the requirements for passing the inspections are especially demanding.

Bertram Elektrotechnik, a company based in the German State of Lower Saxony, spe-

cializes in exactly this business segment. As an industrial material, glass has been a part of the company's local Weser Uplands region since the Middle Ages. Part of Bertram Elektrotechnik's business is developing innovative solutions for the alignment and ejection of container glass as part of process flows in glassworks or filling/packaging businesses. These solutions solve the problem of the careful alignment and feeding of bottles and jars required in a number of processes used in the glass industry and the sectors that it supplies to – such as food and beverages. There are many reasons for this, ranging from the exact positioning needed for precise labelling or the arrangements of packaged goods for palletization to the uniform alignment of the packaged food products that line the shelves of food retailers. Another important aspect here is sidewall inspections, which are used to check for product defects, for example. The wide range of applications where glass packaging is used means they

come in a great many shapes and sizes. As a result, the company needed to develop a product able to map the container glass into a Machine Vision system, regardless of its physical dimensions. The orientation of the different product variants needed to be detected quickly and reliably on the production line – with products then being repositioned as necessary.

Precise Alignment

The resulting Orientator developed by Bertram Elektrotechnik therefore combines a high-precision, highly dynamic servo-driven system with high-throughput industrial machine vision. The fully automatic alignment system combines three process steps into a single, compact machine: isolation, detection of the current alignment and reorientation into the correct position. The alignment unit, which has won the Lower Saxony Innovation Prize awarded by the Karl Moeller Foundation, can align up to 500 glass containers

perfectly every minute. As a first step, the jars and bottles are fed into the machine by the conveyor belt. A separator is used to ensure the correct minimum spacing between the glass receptacles. A purpose-built guide system is used to synchronize the glass containers with the speed of the conveyor belt, so as to ensure that they do not fall over. A photoelectric barrier determines the exact position of the jars or bottles. The software then triggers image acquisition and the analysis of product alignment by the machine vision system. A set of three cameras is used to detect the exact position of the glass containers in a three-dimensional model. Predefined characteristics are then used to calculate the correction angles necessary. The software works out the parameters needed to perform a rotation by the alignment apparatus, which is then executed using a Siemens Simotion control unit. Based on image acquisition data, the glass containers are rotated into the required alignment using the shortest possible path. As it works, the alignment unit is also synchronized with the conveyor belt to avoid displacing the jars/bottles relative to conveyor belt movement.

No Setup Changes Necessary

Uniquely, the Orientator is designed to accommodate a very broad range of glass container types and is therefore able to handle even the most complex use cases. Whatever the various types of jars or bottles that need checking and realigning, however, the entire camera and lighting setup remains unchanged in most cases. This greatly simplifies system setup and retooling since changes only need to be made to the software settings after a product changeover. Even less obvious features can also be learned by the system, enabling the Orientator to detect angles of rotation for many rounded glass products.

Customer-Specific, Homogenous Lighting

An innovative lighting design was required in order to successfully manage this challenge. Lumimax LED Area Lighting solutions featuring LightGuide technology from IIM are the ideal choice for this kind of complex task. The Area Lighting Units here work with specially designed 'light guides', whereby light waves from High Power LEDs are fed into a laser-doped light guide plate before emission – diffused or collimated, just as required – over the entire light field. Thanks to this technology, the lights achieve a homogeneity of more than 90 percent over the entire light field. Collimation ensures optimum levels of contrast in the images, which vastly increases measurement accuracy for the machine vision system. If exterior edges are rounded, diffuse backlight creates a partial shadow, with no binary transition from black to white in the object image. Instead, a grey gradient several pixels wide is produced, making it harder to identify the exact location of the edge. Collimated Lumimax LightGuide Area Lighting is highly directional and the beam angle for the light generated is very low in comparison with the angle created by diffuse illumination. The light field intensity is also exceptionally homogeneous. The effect achieved is similar to that obtained by telecentric lighting. The directed rays of light are refracted directly by edges or embossed elements, for example, making these appear as sharply defined dark areas against a bright background. This kind of edge probing is therefore more exact than with diffuse backlight. For transparent and semi-transparent test objects in particular – such as glass packaging – this kind of collimation therefore offers clear advantages. Apart from glass container shape and alignment, the detection of embossments, engravings, scratches, and inclusions in the
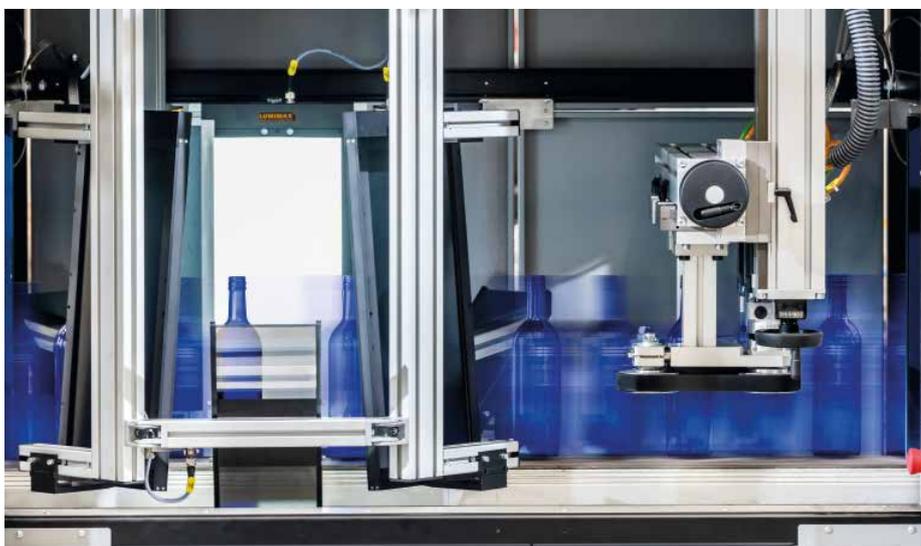
test objects is also made easier. Products from the standard Lumimax ranges were unsuitable because of the size required for the illuminated area. Accordingly, IIM developed a customer-specific lighting solution for Bertram Elektrotechnik that ensures its system is suitable for a very broad spectrum of glass packaging types.

With the collimated Area Lighting solutions from Lumimax, edges and production defects are shown clearly on the object image.

Easy Integration

Overall, the Orientator represents a significant set of improvements for quality control systems, while ensuring that downstream production steps can be designed to be easier and more efficient. As a result, palletizing, filling, sealing and labelling systems can all work significantly faster. Since bottle and jar alignment is a fully automated process, fewer personnel are also required to operate these systems. With its small footprint, the system is easy to integrate into existing conveyor systems. All in all, the smart deployment of machine vision systems achieves improvements to productivity. ∎

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All images: IIM

The Orientator positions up to 500 glass containers fully automatically every minute.

AI Based Code Reading

The Next Step in DPM Code Reading: Automated Learning While Reading

New powerful and intelligent code readers feature the automatic adaptation of the reading strategy, thus enabling maximum process reliability combined with user-friendly operation.

Self-Optimization

The reading strategy of the reader continuously improves in the running process. The more codes are read, the more strategies the integrated software generates or optimizes completely on its own. This makes the system insensitive to possible process fluctuations and eliminates the need for constant adjustments and the associated costs.

Process Reliability

The automatic optimisation of the reading process results in very high process reliability, even in difficult environments. Of course, Ioss' own highly efficient decoding algorithms are also used here for all marking procedures.

Convenient Operation

The systems can be easily and conveniently set up for the user to meet individual needs. Various interfaces, such as Profinet, facilitate integration into systems or working environments. Other useful features include an autofocus, automatic lighting setting, and automatic teach-in. A laser pointer for easy alignment is integrated and two different polarising filters for highly reflective surfaces are available. The readers are offered in various technical versions. Depending on the task, with different sensor resolutions, lenses, and lighting colours. The compact design also allows production lines to be designed more flexibly.

Ioss Intelligente optische Sensoren und Systeme GmbH

Ioss Intelligente optische Sensoren und Systeme GmbH, founded in 1998, develops, produces and sells identification and image processing systems for optical quality assurance and process automation. The products are used in a variety of industrial fields, such as automotive, semi-conductor, solar and medical engineering.

Based in Radolfzell, Germany, the company sets itself apart with innovative concepts and products. With customer-specific OEM systems they also offer their clients customized solutions.

They are the right partner when it comes to the reading and verification of 2D codes. Whether fixed mount readers or hand-held scanners, the reading systems are convenient, efficient, and reliable. The fixed mount readers decode and verify directly marked 2D codes according to the ISO/IEC 29158 (formerly AIM-DPM) and to a proprietary validation standard called rated reading for dot-peened codes. The plain text readers (OCR readers), which can be taught a variety of reading functions in an efficient and flexible manner thanks to their modular design, have proven valuable in the day-to-day industrial routine.

The new code readers of the DMR4XX line can be seen in operation at Ioss' booth 7505 in hall 7 at Motek Stuttgart from 5th to 8th October 2021.

The systems are applicable for all Data Matrix codes in industrial areas such as automotive, semiconductor, logistics, automation, and many other industries.

The code readers are available with two different sensor resolutions: DMR410 with 800 x 600 pixels and DMR420 with 1,440 x 1,080 pixels. ∎

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Image: Ioss

Cleanliness inspection system with microscope mode

The Olympus CIX100 cleanliness inspection system's latest software update includes a new microscope mode, providing component manufacturers with an all-in-one imaging solution for particle analysis and microscope inspections. The CIX100 system is a turnkey solution dedicated to technical cleanliness inspection with a guided workflow, analysis tools and integrated industry standards. An optimized autofocus routine and optional overview scan in CIX software version 1.5 speed up the automated analysis, making it even easier to achieve repeatable results quickly. The new microscopy mode enables users to leave the dedicated cleanliness inspection workflow to perform microscopic imaging for other applications. Microscope mode capabilities can be expanded with a suite of optional material analysis solutions—from interactive microscopy and layer thickness measurement in surface coatings to the automatic evaluation of grain sizes—enabling users to customize the system for their needs.

www.olympus-ims.com
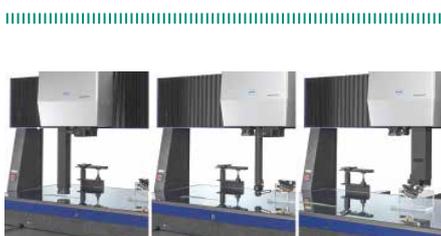
More sensor axes possible

The ScopeCheck FB from Werth Messtechnik is now optionally available with one, two or three independent sensor axes. The multi-sensor system is perfectly integrated and can therefore be used without restriction and without time-consuming sensor changes. Each sensor is mounted on its own Z-quill, the parking positions are outside the measuring range. For example, the patented multi-sensor from Werth Zoom and Werth Laser Probe and a conventional button on the rotary-swivel joint can be supplemented by the also patented Werth Fiber Probe 3D on the third quill. With measuring ranges from 530 x 500 x 350 mm to 2130 x 1000 x 600 mm, the device family is ideal for measuring a wide range of even larger workpieces.

www.werth.de

Industrial CT software suite in new version

Volume Graphics present the latest version of our industrial CT software suite. In version 3.5.0, you can look forward to a completely reworked Manufacturing Geometry Correction Module, enhanced mesh compensation for correcting 3D printing geometries, and new BDG P 203 analysis functions, among other new and exciting features. Among other features, it has a completely reworked Manufacturing Geometry Correction Module for geometry compensation: a new filter option allows you to find fit points causing inaccurate compensation results. You can now rigidly relocate patch compounds with constraints. The improved surface fitting with user-controlled smoothness of surface offers better output quality and enhanced user-friendliness. Also, hairlines now indicate the deviations between the fitted surface and the compensated points for a more accurate interpretation of used fitting parameters. Real-time surface fitting improves your user experience and speeds up your workflow. **www.volumegraphics.com**

Optical alignment systems and scanners in focus

Aerotech presented the multi-axis photonic alignment system FiberMaxHP at the ECOC Exhibition, a trade fair for fiber optics and communication technology. The movement system is based on the proven high-performance ANT nanopositioners. FiberMaxHP is used in large-volume manufacturing for aligning and testing optoelectronic devices and photonics components with submicrometer tolerances. The precision mechanics are coupled to the Aerotech A3200 controller, which is a low-latency motion controller and prescribed optical alignment algorithms. This

means that all automation processes can be programmed via a single control interface.

For the first time, the system is also equipped with the current Aerotech control Automation1, which also received a new release in February. The advantage for the user: ETM modules and other peripherals can be seamlessly integrated into the processes via an integrative portal control scheme.

**www.aerotech.com**

Robust thermal imaging cameras

The robust thermal imaging cameras Flir A500f and A700f Advanced Smart Sensor have high temperature detection for extreme environments as well as internal analysis and alarm functions. This makes them ideal for early fire detection in indus-

trial environments and condition monitoring outdoors. Together with its advanced point, area, line, polygon and auxiliary contour analysis functions that improve the definition of target areas and object curvatures, the A500f / A700f can help commercial and industrial organizations protect their facilities, improve safety to maximize availability and minimize maintenance costs.

In addition, the A500f / A700f cameras are effective tools for fire monitoring in garbage dumps and provide automatic early warnings for potential problems in 24/7 waste disposal facilities and coal collection areas. **www.teledyneflir.de**
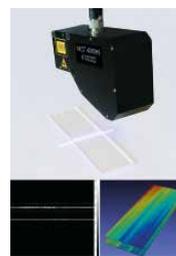
New 3D sensors for machine vision

Automation Technology has presented the new 3D sensor module cx4090HS. It is the first product in its new C6 series. GenICam 3D is implemented, which enables a problem-free connection between software and 3D camera via plug & play. With GenICam 3D, specific features are no longer required across software for communication between application and hardware.

Two further decisive advantages of the new standard interface are the two features MultiPart and MultiPeak. Thanks to MultiPart, it is now possible to output significantly more features regardless of the pixel format and algorithm.

In addition to the altitude values, the user also receives intensity data, for example. These provide information about the so-called reflectance, which evaluates the contrast representation, as well as the scatter value, which analyzes the surface quality. With MultiPeak, the user can finally define an exact peak, which means that incorrect measurements due to reflections, for example, are now excluded. Thus, both MultiPart and MultiPeak enable the recorded 3D data to be evaluated in more detail and the customer benefits from a significantly more extensive and stable analysis capability of the 3D sensor.

www.automationtechnology.de

Telephoto lenses for laser process observation

Sill Optics has presented telephoto lenses with adjustable focus for laser process observation: The models S5VPJ0303 and S5VPJ0305 are intended to represent new inexpensive alternatives to specially color-corrected F-Theta lenses. The lenses with a focal length of 153mm and 305mm are designed for a high image scale and for 2/3 " sensors. The achievable imaging performance depends on the scanner aperture. Customer-specific designs for larger scanner apertures or different focal lengths and sensor sizes are possible on request.   **www.silloptics.de**

Profile projector for harsh environments

As the successor to the tried and tested PJ-3000, Mitutoyo's new PJ-Plus with its functions ensures reliable measurements even in harsher environments in which conventional models cannot be used. The device is the choice for use in production and processing lines in which 2D quality assurance is required.

The profile projector has, thanks to the use of LED light sources and a fanless cooling system, an excellent durability and low power consumption. The new light source not only brings greater energy efficiency and resilience in harsh working environments, but it also offers illuminance that is about twice as long as its predecessor.

www.mitutoyo.de

Second generation of autonomous machine vision systems

With the S70 Gen.2, Inspekto has launched a new and improved version of its proven AMV (Autonomous Machine Vision) system for industrial quality inspection. S70 Gen.2 is based on the technology Autonomous Machine Vision AI (AMV-AI) and supports an even higher number of use cases. The system enables reliable quality testing in demanding applications such as highly reflective materials, moving parts and vibrating platforms.

Although the system enables high quality inspection in a greater number of scenarios than before, the system maintains its speed and extremely easy installation. In contrast to conventional machine vision solutions, the S70 Gen.2 is a standard system that users can install in just 45 minutes without any knowledge of image processing or AI. The simple setup process only requires an average of 20 to 30 good sample parts and does not have any defective parts. This means that no training, no labeling or other markings are required to immediately create a feasibility study.

www.inspekto.com

3D solder paste inspection

Viscom introduces the new S3088 Ultra Chrome a 3D SPI solution. The 3D SPI S3088 Ultra Chrome checks with an integrated verification all the quality criteria for printed pads such as volume, area, height, offset, and smearing paste bridges - for solder and sintering paste. The XM camera technology successfully developed by Viscom in the high-end area for 3D-AOI has now also been optimized for 3D-SPI. For the 3D solder paste inspection, four side cameras provide angled views for shadow-free and precise measurement results. The XM sensors enable more precise error detection at a high-test speed. The orthogonal optical resolution is 10 μm, which makes it possible to inspect very small test areas, such as B. solder paste for 01005 components and also gaps, improved again. The test speed is 90 cm² / s with an image field size of 58.2 mm x 58.2 mm. With optimized, external handling, it is possible to reduce the number of components to be changed from standard size printed circuit boards to as little as 2.5 seconds.   **www.viscom.com**


Short pulse testing for high power LEDs

To carry out short pulse measurements, spectroradiometers with minimal measurement times in the microsecond range and a precise trigger are required. Instrument Systems has therefore designed the new CAS 125 spectroradiometer with CMOS sensor and specially developed readout electronics. These device-specific readout electronics allow time-optimized control of the spectrometer and enable minimal integration times of 0.01 ms - 40 times faster than the CAS 140D. Precise triggering is also essential so that the LED has reached a stable level within the short integration time and can be measured in a time-optimized manner at the same time. An I / O interface enables precise timing with other triggerable system components, such as pulsed power sources or pulsed measuring units.

www.instrumentsystems.com
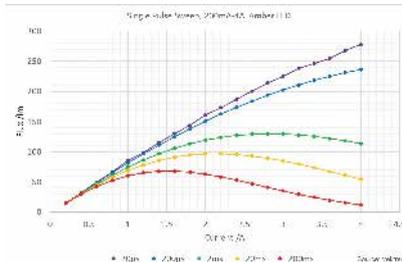
AI-capable intelligence for robotics applications

Xilinx has introduced the new Versal AI Edge series. It enables rapid AI innovations from the edge to the endpoint. With 4 times the AI performance per watt compared to GPUs and 10 times the computing density compared to adaptive SoCs of the previous generation, the Versal AI Edge series offers a scalable and flexible portfolio for distributed intelligent systems.

The Versal AI Edge series uses the production-proven 7 nm Versal architecture and miniaturizes it for AI computing power with low latency, all with a power consumption of only six watts and with the security measures required in edge applications. As a heterogeneous platform with different processors, the Versal AI Edge series adapts the engine to the algorithm, with Scalar Engines for embedded calculations, Adaptable Engines for sensor fusion and hardware adaptability and Intelligent Engines for AI inference that can handle up to 479 (INT4) TOPS scales and for advanced signal processing workloads for vision, radar, LiDAR and software defined radio.

www.xilinx.com

Multi-beam interferometer for every application

The single and multi-beam interferometers from Sios address a wide variety of application scenarios - from calibration tasks and simultaneous displacement-angle measurements to highly stable differential measurements and vibration analyzes to multi-axis system combinations in which three-dimensional processes are recorded. The basic concept of all versions is embodied in the compact single-beam calibration interferometer of the SP-NG product family, the sensor head including the adjustment joint only measures 133 x 91 x 54 mm – or 227 x 91 x 67 mm for measurements of great lengths. This is because it is a precision length measuring system in which the individual measuring beam is reflected by the reflector on the same path, i.e. in itself. Thanks to this proven principle, there is a defined contact point on the measuring object, so that alignment errors and the typical Abbe error can be compensated. The optical properties of the reflectors make it possible to identify and correct such alignment errors. **www.sios.de**

Through walls measure

With the new MSA-650 Iris Micro System Analyzer from Polytec, the MEMS developers can now record the movement of the MEMS components directly through the silicon cap of the component with high resolution in real time - at frequencies of up to 25 MHz. This is made possible by an innovative, patented measurement technology using a special infrared interferometer. The integrated IR camera also looks through the cap, provides high-resolution images of the MEMS mechanics and enables the planar movement components ("in-plane") to be measured using stroboscopic video microscopy.
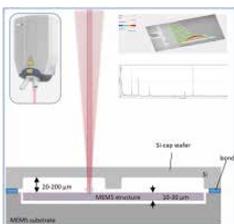
The main advantages of the new MSA are the fast measurement under the actual operating conditions without time-consuming preparation and the excellent data quality due to the short-coherent interferometric suppression of interference. **www.polytec.de**

Measuring device for cables and hoses

IIM has introduced the new automatic wall thickness and geometry measuring device Alpha One. It is equipped with only one field of view. The idea behind this concept: In a cable factory, various intermediate stages such as cores and jackets are produced on different extrusion lines, whereby the diameter range of the cables produced in the individual extruder lines remains relatively constant. At this point, the Alpha One is placed directly in the individual lines and thus saves the workers time-consuming walking distances during the intermediate tests. In addition, it enables even faster intervention in the process. Due to its compact and space-saving design, several measuring devices can be placed on various production lines within a plant.

In addition to a homogeneous background lighting for measuring single-layer samples, the Alpha One also has a white incident light which can be used to measure a large number of simple multi-layer samples. **www.iim-ag.com**

3D laser profile sensor with two cameras

With Altiz, Matrox Imaging has introduced a 3D laser profile sensor which, using two integrated cameras, ensures maximum precision and minimizes scan gaps. With four AltiZ models and three working areas from 55 to 310 mm in the X direction and 100 to 545 mm in the Z direction, Matrox Imaging covers a wide range of possible 3D applications. If the detection range of a 3D profile sensor is not sufficient, there is also the option of cascading several AltiZ systems to achieve the required scan width. For each of the three work areas there is a model with a red laser that produces a line that is optimally recognizable for the cameras on most materials. A model with blue laser light is also available for testing plastic objects.

Possible areas of application of AltiZ include the automotive industry, electronics manufacturing, food and pharmaceutical production and many other industrial sectors in which three-dimensional objects must be checked quickly and with high accuracy. **www.rauscher.de**

Computer tomograph for non-destructive component inspection

With Zeiss Metrotom 1, Zeiss is now bringing an entry-level solution for the non-destructive testing of components onto the market. The compact computer tomograph delivers precise results and is still easy to use. The GOM Volume Inspect software, which is tailored to the hardware, guarantees users easy operation of the new computer tomograph, from the acquisition of measurement data through to evaluation. According to Schmidt, the latest version of the software will also be equipped with significantly more volume functions. An investment in additional software for detailed data analysis is no longer necessary for the metrological evaluation.

The compact device, which is only 175 centimeters wide and 87 centimeters deep, can be used to measure small to medium-sized components made of plastic or light metal such as connectors, plastic caps or aluminum housings. **www.zeiss.de**
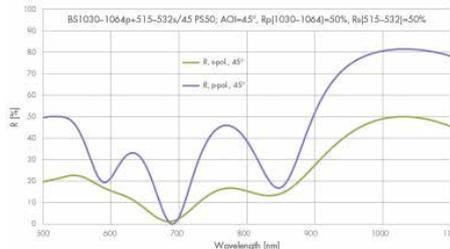
Beam splitter for industrial applications

Laser Components has developed a beam splitter in which the combined beam of a frequency-doubled laser is split in such a way that 50% of the two wavelengths are split off even with different polarizations. The polarization is retained in both beams. Previously, a beam splitter and a retardation plate were required for this process. The manufacturer has now succeeded in combining both functions in one look. In this way, the construction and maintenance of the entire system can be considerably accelerated in the future.

The original design is for 1030 nm and 515 nm. Wavelengths, polarization and reflection / transmission ratio can be individually adjusted depending on the application. **www.lasercomponents.de**

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Imprint

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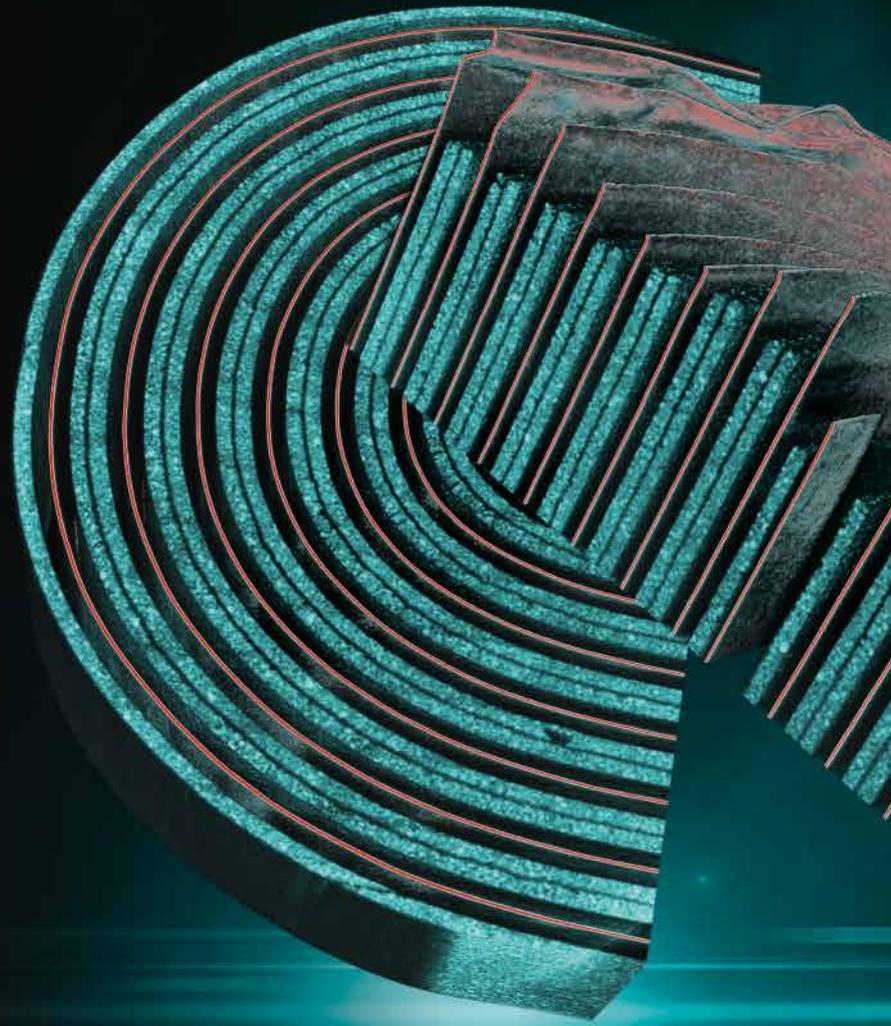
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1942 | Edmund Scientific® was founded by Norman Edmund in New Jersey, USA

1998 | Design Center opened in Arizona, USA
Optikos® MTF Test Bench Acquired
First TECHSPEC® M12 S-Mount Lenses Launched

2005 | Edmund Optics® China Factory & Design Center Opened

1999 | First TECHSPEC® Telecentric Lenses Launched

2007 | First TECHSPEC® Fixed Focal Length Lenses Launched

2015 | Vision Systems Design **Innovators Award, Bronze TECHSPEC® Dynamic Focus VZM™ Lens**

2015 | Vision Systems Design **Innovators Award, Silver TECHSPEC® VariMagTL™ Telecentric Lenses**

2016 | Vision Systems Design **Innovators Award, Silver TECHSPEC® Cx Series Lenses**

2017 | Trioptics ImageMaster® MTF Test Bench Acquired

2021 | Vision Systems Design **Innovators Award, Gold** and **Inspect Award Winner Vision Category, 3rd place TECHSPEC® LT Series Lenses**

2017 | Inspect Award Winner 2017 **Vision Category, 2nd place TECHSPEC® Cx Series Lenses**

2018 | Vision Systems Design **Innovators Award, Silver TECHSPEC® Ruggedized Cr Series Lenses**

2017 | Vision Systems Design **Innovators Award, Silver TECHSPEC® TitanTL™ Lenses**

2021 | Vision Systems Design **Innovators Award, Bronze TECHSPEC® Cw Series Lenses**

2020 | Vision Systems Design **Innovators Award, Silver TECHSPEC® CA Series Lenses**

2019 | Inspect Award Winner **Vision Category, 2nd place TECHSPEC® Liquid Lens M12 Lenses**

2018 | Inspect Award Winner **Vision Category, 1st place TECHSPEC® Ruggedized Cr Series Lenses**

Greg Hollows
Vice President,
Edmund Optics® Imaging

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As high-performance imaging and rapid sensor technology continues to evolve, Edmund Optics® has matched these advancements with both in stock, ready-to-ship products, capability for custom design solutions, and partnership with industry leaders to solve your application challenges. Here at Edmund Optics®, we believe **The Future Depends on Optics.** "

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TECHSPEC®
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produced per year

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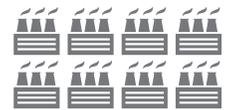
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Mary Turner, Ph.D.
Technical Fellow,
Optical Design
(7+ years at Zemax,
3+ years at Edmund Optics®)

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Zygo®
Interferometer

Trioptics
ImageMaster®

Jeremy Chang, Ph.D.
Vice President of Asia
Manufacturing, General Manager
of Edmund Optics® China

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Kenneth Barber, Jr.
Director, Engineering and Project Management

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- 🟦 Distribution Center
- 🩷 Design Location
- 🟥 Sales Location
- 🟩 Sales Representative
- 🔵 Imaging Optics Lab

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- California
- Arizona
- New Jersey
- Florida
- Mexico
- Brazil
- United Kingdom
- France
- Germany
- Finland
- Russia
- Israel
- India
- China
- Taiwan
- South Korea
- Japan
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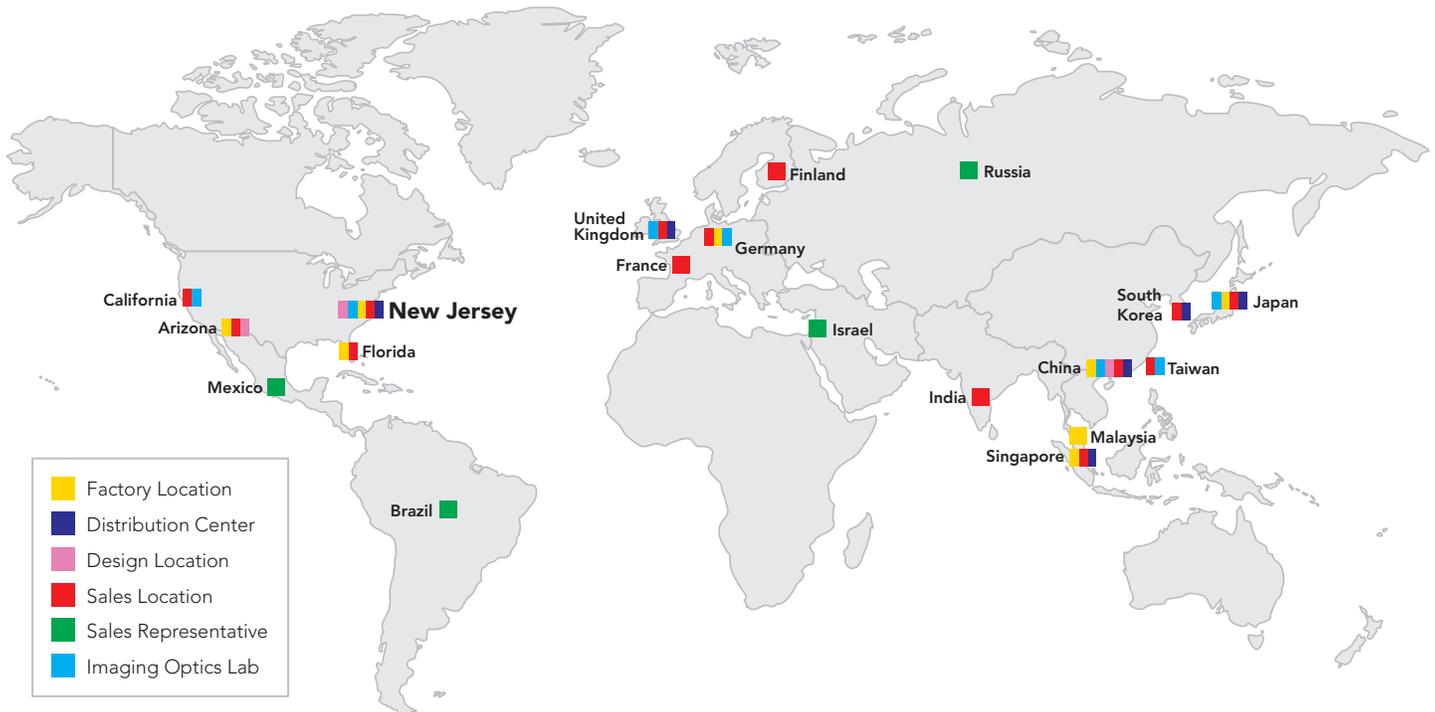
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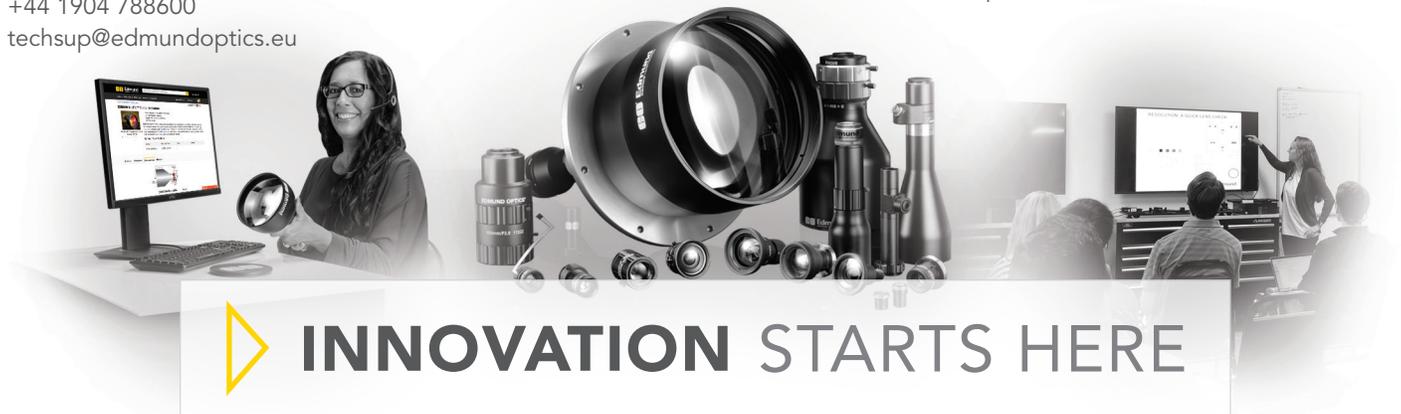
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- Low Lens to Lens Variation
- C-Mount Lens Mount

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Max. Sensor Format:	⅟₁,₈"	⅟₁,₈"	⅟₁,₈"	⅔"	⅔"
Horizontal FOV on ⅟₁,₈" Sensor:	41,2 mm - 102,8°	72,0 mm - 84,7°	110,3 mm - 62,1°	101,0 mm - 49,2°	68,0 mm - 34,2°
Horizontal FOV on ⅔" Sensor:	–	–	–	128,6 mm - 60,6°	83,6 mm - 41,4°
Horizontal FOV on ⅘" Sensor:	–	–	–	–	–
Working Distance:	0 mm - ∞	25 mm - ∞	75 mm - ∞	100 mm - ∞	100 mm - ∞
Distortion:	< 24%	< 14%	< 7,5%	< 15%	< 2,5%
Aperture (f/#):	f/2,0-f/11	f/2,0-f/11	f/1,4-f/16	f/1,3-f/16	f/1,8-f/16
Stock No.	#89-410	#86-900	#67-709	#58-000	#58-001

TECHSPEC® C Series Fixed Focal Length Lenses					
Focal Length:	16 mm	25 mm	35 mm	50 mm	100 mm
Max. Sensor Format:	⅔"	⅔"	⅔"	⅔"	⅘"
Horizontal FOV on ⅟₁,₈" Sensor:	50,1mm - 25,5°	29,9 mm - 16,2°	32,0 mm - 11,7°	34,7 mm - 6,9°	45,2 mm - 4,1°
Horizontal FOV on ⅔" Sensor:	61,4 mm - 30,9°	36,6 mm - 19,7°	39,3 mm - 14,3°	42,5 mm - 8,5°	55,2 mm - 5,0°
Horizontal FOV on ⅘" Sensor:	–	–	–	–	108,7 mm - 9,7°
Working Distance:	100 mm - ∞	100 mm - ∞	165 mm - ∞	250 mm - ∞	750 mm - ∞
Distortion:	< 1,25%	< 0,7%	< 0,3%	< 0,2%	< 0,1%
Aperture (f/#):	f/1,6-f/16	f/1,4-f/17	f/1,65-f/22	f/2,0-f/22	f/2,8-f/22
Stock No.	#59-870	#59-871	#59-872	#59-873	#86-410

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- C-Mount
- Ultra-Compact (UC) Series

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Fixed Focal Length Lenses

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- Medium Sensor Format
- 3,5 mm to 100 mm Focal Length
- C-Mount
- Compact (C) Series

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Fixed Focal Length Lenses

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- C-Mount
- High Performance (HP) Series

www.edmundoptics.eu/hp-series

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Fixed Focal Fixed Focal
Length Lenses

- Integrated Liquid Lens Autofocus
- 1,1" Sensor Format,
- 3,45 μm Pixel Size
- Up to 12 MegaPixels
- Maximized Resolution and Focus

www.edmundoptics.eu/lt-series

TECHSPEC® CA Series
Fixed Focal Length Lenses

- 30+ MegaPixels
  (Up to APS-C Format)
- Large Sensor Format
- 50 mm to 100 mm Focal Length
- TFL-Mount
- Compact APS-C (CA) Series

www.edmundoptics.eu/ca-series

TECHSPEC® LF Series
Fixed Focal Length Lenses

- 29+ MegaPixels
  (Up to 35 mm Format)
- Large Sensor Format
- 28 mm to 100 mm Focal Length
- F-Mount
- Large Format (LF) Series

www.edmundoptics.eu/lf-series

TECHSPEC® LS Series
Fixed Focal Length Lenses

- 3,45 mm Pixels
- 82 mm, 16K Line Scan
- 1,67X to 2,5X
- V-Mount
- Line Scan (LS) Series

**www.edmundoptics.eu/ls-series**

TECHSPEC® SWIR Series
Fixed Focal Length Lenses

- 3 MegaPixel
  (Up to 25,6 mm Image Circle)
- Large Sensor Format
- 25 mm to 100 mm Focal Length
- C-Mount, F-Mount,
  and M42 x 1,0 Options
- Short-Wave Infrared (SWIR) Lenses

www.edmundoptics.eu/swir-series

TECHSPEC® Edmund Optics® Imaging Lenses are designed, manufactured, and guaranteed by Edmund Optics®

TECHSPEC® Telecentric Lenses
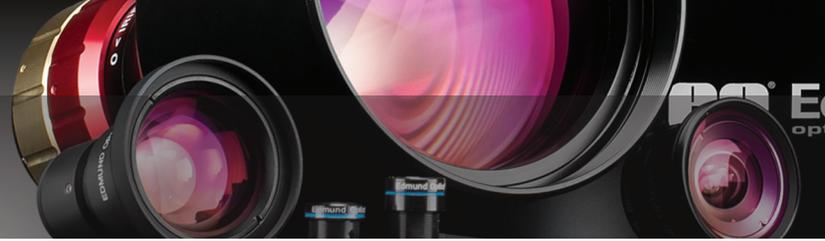
Telecentric lenses eliminate parallax error, making them ideal for high precision measurement and gauging applications. Many EO Imaging telecentric lenses feature an f/6 aperture for increased light throughput, while still providing high performance.

TECHSPEC® CompactTL™ Telecentric Lenses

- 2 MegaPixels (Up to ⅔" Format)
- Medium Sensor Format
- 0,5X to 8X Magnification
- f/9 Maximum Aperture
- C-Mount
- Small Form-Factor for Space-Restrictive Applications
- In-Line Illumination Available

www.edmundoptics.eu/compact-tl

TECHSPEC® MercuryTL™ Liquid Lens Telecentric Lenses

- 3 MegaPixels (Up to ⅔" Format)
- Small Sensor Format
- 0,15X to 0,75X Magnification
- f/10 Nominal Aperture
- C-Mount
- Integrated Liquid Lens for Quick Autofocus

www.edmundoptics.eu/mercury-tl

TECHSPEC® VariMagTL™ Telecentric Lenses

- 5 MegaPixels (Up to ⅔" Format)
- Medium Sensor Format
- 0,15X to 3X Magnification
- f/4 Maximum Aperture
- C-Mount
- Adjustable Field of View
- Telecentric and Non-Telecentric Designs Available

www.edmundoptics.eu/varimag-tl

TECHSPEC® CobaltTL Telecentric Lenses

- 20 MegaPixels (Up to 1,1" Format)
- Large Sensor Format
- 0,28X to 0,9X Magnification
- f/4 Maximum Aperture
- C-Mount
- High Resolution Bi-Telecentric Lens with In-Line Illumination Options

www.edmundoptics.eu/cobalt-tl

TECHSPEC® SilverTL™ Telecentric Lenses

- 5 MegaPixels (Up to ⅔" Format)
- Medium Sensor Format
- 0,16X to 4X Magnification
- f/6 Maximum Aperture
- C-Mount
- High Resolution on Medium Sensor Formats
- In-Line Illumination Versions

www.edmundoptics.eu/silver-tl

TECHSPEC® GoldTL™ Telecentric Lenses

- 5 MegaPixels (Up to ½" Format)
- Medium Sensor Format
- 0,06X to 1X Magnification
- f/6 Maximum Aperture
- C-Mount
- Focusable to Allow for Working Distance Adjustment

www.edmundoptics.eu/gold-tl

TECHSPEC® PlatinumTL™ Telecentric Lenses

- 35 MegaPixels (Up to 28,7 mm Image Circle)
- Large Sensor Format
- 0,28X to 1,7X Magnification
- f/6 Maximum Aperture
- C-Mount and F-Mount Options
- High Resolution on Large Sensor Formats

www.edmundoptics.eu/platinum-tl

TECHSPEC® TitanTL™ Telecentric Lenses

- 14 MegaPixels (Up to 35 mm Format)
- Medium and Large Sensor Formats
- 0,37X to 0,38X Magnification
- f/8 Maximum Aperture
- C-Mount, F-Mount, M42, and M58 Options
- Large Field of View Options Available

www.edmundoptics.eu/titan-tl

▷ **INNOVATION** STARTS HERE

M12 Lenses or **S-Mount Lenses** are compact, board lenses design for use in many small format cameras. Edmund Optics® Imaging's all glass and metal designs provide a reliable, high performance solution.

TECHSPEC® Blue Series
M12 Imaging Lenses

- 6+ MegaPixels (Up to ½" Format)
- Small Sensor Format
- 2 mm to 25 mm Focal Length
- S-Mount (M12 x 0,5)
- Optimized for High Resolution Performance at Machine Vision Working Distances

www.edmundoptics.eu/m12-blue-series

TECHSPEC® Green Series
M12 Imaging Lenses

- 3 MegaPixel (Up to ½" Format)
- Small Sensor Format
- 6 mm to 25 mm Focal Length
- S-Mount (M12 x 0,5)
- Optimized for Machine Vision Working Distances

www.edmundoptics.eu/m12-green-series

TECHSPEC® Red Series
M12 Imaging Lenses

- 3 MegaPixel (Up to ½" Format)
- Small Sensor Format
- 3,6 mm to 8 mm Focal Length
- S-Mount (M12 x 0,5)
- Optimized for High Resolution Performance to Infinity

www.edmundoptics.eu/m12-red-series

TECHSPEC® Rugged Blue Series
M12 Imaging Lenses

- 6+ MegaPixels (Up to ½" Format)
- Small Sensor Format
- 2 mm to 25 mm Focal Length
- S-Mount (M12 x 0,5)
- Ruggedized Versions of our Blue Series

www.edmundoptics.eu/m12-rugged-blue

TECHSPEC® HEO™ Series
M12 Imaging Lenses

- 3 MegaPixel (Up to ½" Format)
- Small Sensor Format
- 2,2 mm to 8 mm Focal Length
- S-Mount (M12 x 0,5)
- Harsh Environment Optics (HEO) Sealed Versions of our Red Series

www.edmundoptics.eu/m12-heo-series

TECHSPEC® Liquid Lens
M12 Imaging Lenses

- 6+ MegaPixels (Up to ¹⁄₁,₈" Format)
- Small Sensor Format
- 6 mm to 16 mm Focal Length
- S-Mount (M12 x 0,5)
- Integrated Liquid Lens for Quick Autofocus

www.edmundoptics.eu/m12-liquid-series

TECHSPEC® Edmund Optics® Imaging Lenses are designed, manufactured, and guaranteed by Edmund Optics®

Objectives from Industry-Leading Manufacturers

Mitutoyo   Nikon®   OLYMPUS   ZEISS

Microscopy Objectives

- Wide Variety from Industry-Leading Manufacturers
- Infinity Corrected, Finite Conjugate, Tube Lenses, Microscope Systems, and More

To view our full selection of objectives, visit our website at
www.edmundoptics.eu/microscopy

Mitutoyo Infinity Corrected Long Working Distance Objectives

- Long Working Distances
- Bright Field Inspection
- High Quality Plan Apochromat Design
- Flat Image Surface over Entire Field of View

www.edmundoptics.eu/1942

Mitutoyo NIR, NUV, and UV Infinity Corrected Objectives

- Ideal for Bright Field Imaging in UV, Visible, and NIR Spectral Regions
- Excellent Performance at Nd:YAG Laser Lines
- Broad Spectral Ranges

www.edmundoptics.eu/1950

Olympus Long Working Distance M-Plan Fluorite Objectives

- Ideal for Brightfield, Darkfield, DIC, Fluorescence, or Polarization Microscopy
- Long Working Distances Reduce Risk of Specimen Damage

www.edmundoptics.eu/3509

Olympus X-Line Extended Apochromat Objectives

- High NA up to 1,45
- Chromatic Aberration Correction from 400 - 1000 nm
- Uniform Image Flatness over Large FOVs

www.edmundoptics.eu/4080

Nikon CFI60 Infinity Corrected Brightfield Objectives

- Excellent Color Reproduction
- Long Working Distance and High NA
- High Contrast with Minimal Flare
- Strain Free

www.edmundoptics.eu/2690

Nikon Interferometry Objectives

- Suitable for Non-Contact Optical Profiling
- Michelson and Mirau Objectives Available
- Infinity Corrected 200 mm

www.edmundoptics.eu/2797

ZEISS A-Plan Objectives

- Ideal for Brightfield and Fluorescence Applications
- Excellent Color Correction and Flatness of Field
- Oil Immersion Options Available

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ZEISS EC Epiplan Objectives

- Ideal for Brightfield, Fluorescence, and Differential Interference Contrast Applications
- Enhanced Contrast
- Excellent Color Correction and Flatness of Field

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INNOVATION STARTS HERE

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To view our full selection of cameras, visit our website at
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Allied Vision Alvium USB 3.1 Cameras
- Compact, Low Cost, High Performance
- Onboard Imaging Preprocessing
- Up to 20,2 MegaPixels, 1,1" Sensor Format

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Basler ace2 GigE Cameras
- SONY Pregius S Sensors Available with up to 24 MP
- Proven Compact Housing (29 x 29 mm)
- Powerful Computer Vision Feature Set with Optional Beyond Features

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IDS Imaging uEye+ USB3 Cameras
- Compact, Robust Housing
- Feature High Resolution, High Sensitivity Sensors
- GenICam USB3 Vision Compliant

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FLIR Blackfly® S PoE GigE Cameras
- PoE (Power over Ethernet)
- VGA to 20 MP Resolution
- Compact 29 x 29 x 30 mm Size
- Extensive API library and Included SDK

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Lucid Vision Labs Atlas10 10GigE Power over Ethernet (PoE) Cameras
- 10 GigE Ethernet Interface with PoE+
- 16,2 to 24,5 Megapixel Sony 4th Gen Pregius S Sensors
- Compact 55 x 55 mm Form Factor

www.edmundoptics.eu/4154

Teledyne Dalsa Genie™ Nano 5GigE Power over Ethernet (PoE) Cameras
- 5GBASE-T (5GigE) Ethernet Interface
- 3,2 to 12,4 Megapixel Sensors
- TurboDrive™ Technology for Data Transfer Speeds up to 985 MB/s

www.edmundoptics.eu/4106

PixeLINK® USB 3.0 Autofocus Liquid Lens Cameras
- Seamless Integration of Liquid Lenses
- One-Push Autofocus, High Speed Focus Movement
- Easy-to-Use USB 3.0 Interface

www.edmundoptics.eu/3781

1500 - 1600 nm NIR CCD USB 2.0 Camera
- Phosphor Coated CCD Array
- Spectral Peaks at 1512 nm and 1540 nm
- Includes Camera, Cable, and Easy-to-Use Software

www.edmundoptics.eu/3599

Meet our partners. We partner with industry-leading manufacturers to offer the widest selection of imaging products and have unique access to technical support to solve customer applications with speed and ease.

Liquid Lenses in Edmund Optics® Imaging

- Integrate Liquid Lenses Into Imaging Assemblies for Quick Autofocus
- Compensate for Different Object Sizes and Working Distances
- Increase Throughput in High-Speed Machine Vision Systems
- Ideal for Barcode Reading, Rapid Automation, Package Sorting, and Security

Conventional imaging lenses struggle to capture sharp and accurate images in high-speed or precise applications that require quick refocusing. Liquid lenses overcome these limitations by quickly adjusting focus to accommodate for objects located at various working distances or objects of different heights. Liquid lenses are small cells containing optical-grade liquid that change their shape when a current or voltage is applied. This occurs within a matter of milliseconds and causes the lens' optical power, and therefore focal length and working distance, to shift. Integrating liquid lenses into imaging systems is an ideal solution for applications requiring rapid focusing, high throughput, and accommodation for depth of field and working distance.
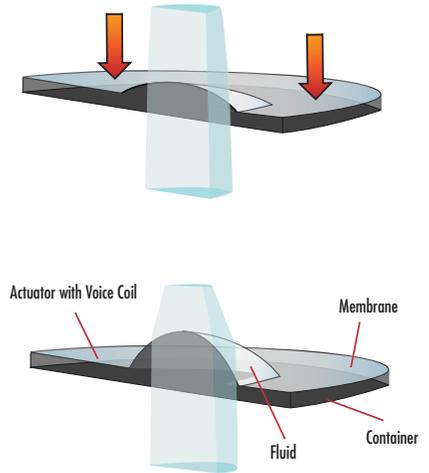
The figure on the right shows how electronic focus can be quickly changed by applying a current or voltage to the liquid lens. This allows for quick autofocus without need for manual adjustment.

Actuator with Voice Coil — Membrane — Fluid — Container

TECHSPEC® LT Series Fixed Focal Length Lenses

- Integrated Liquid Lens Allows for Dynamic Autofocus
- 1,1" Sensor, up to 12 MegaPixels, 3,45 μm Pixel Size
- Maximizes the Liquid Lens Performance for Resolution, Range and Focus Speed

www.edmundoptics.eu/ lt-series

TECHSPEC® MercuryTL™ Liquid Lens Telecentric Lenses

- Integrated Liquid Lens for Quick Autofocus
- Imaging Performance of a Telecentric with the Flexibility of a Liquid Lens
- Telecentricity Maintained Throughout Working Distance Range
- Silver Level 2015, VSD Innovators Award

www.edmundoptics.eu/mercury-tl

TECHSPEC® Liquid Lens Cx Series Fixed Focal Length Lenses

- Integrated Liquid Lens for Quick Autofocus
- Compact Flexible (Cx) C-Mount Designs
- Electronic Focus
- Versions Without a Liquid Lens
- Silver Level 2016, VSD Innovators Award

www.edmundoptics.eu/cx-series

TECHSPEC® Liquid Lens M12 Imaging Lenses

- Integrated Liquid Lens for Quick Autofocus
- High Light Throughput f/2,4 Designs
- Compact M12 Mount
- 2nd Place Winner, 2019 VSD Inspect Award

www.edmundoptics.eu/ m12-liquid-lenses

INNOVATION STARTS HERE

Ruggedized Edmund Optics® Imaging Lenses

- Stability Ruggedized
- Internal Optics Glued in Place
- Minimize Pixel Shift after Shock and Vibration
- 50G Shock Rating with Sub-Micron Pixel Shift < 1um

In a standard imaging lens, the space between the outer diameter of the lens element and inner diameter of the barrel is small (typically less than 50 microns). However, even this small decenter of the lens elements is enough to significantly affect the optical pointing stability of the lens and cause pixel shift during shock and vibration. In a stability ruggedized imaging lens, all of the individual lens elements are glued in place to protect the lens from damage and maintain the object-to-image mapping after heavy shock and vibration; if the center of the object maps onto the center pixel, it will always map to that same center pixel. Stability Ruggedization is important in applications where the field of view is calibrated, such as measurement and gauging, 3D stereo vision, robotics and sensing, autonomous vehicles, and object tracking. These applications often require the pointing (or pixel shift) to be stabilized to values much smaller than a single pixel.

Figure on right compares a standard imaging lenses (top) with our ruggedized Cr Series Lens (bottom). While the standard C Series Lens performs well, the pixel shift after 50 G of shock is still greater than a pixel. Our Stability Ruggedized Cr Series Lens has less than 1μm of pixel shift – much smaller than the size of a pixel!

STANDARD C SERIES LENS AFTER 50G SHOCK

RUGGEDIZED Cr SERIES LENS AFTER 50G SHOCK

RUGGEDIZED Cr SERIES LENS AFTER 50G SHOCK — SIZE OF ONE PIXEL
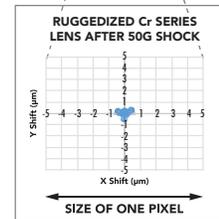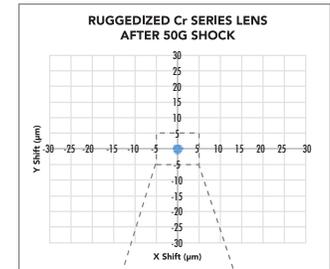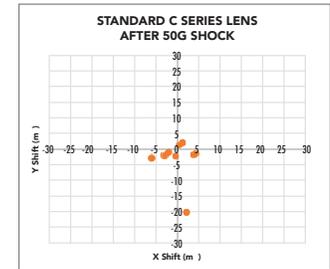
TECHSPEC® Cr Series Fixed Focal Length Lenses

- Compact Ruggedized (Cr) Versions of our C Series Lenses
- Ruggedized to Minimize Pixel Shift After Shock and Vibration
- Individual Optics Glued in Place to Maintain Optical Pointing Stability

www.edmundoptics.eu/cr-series

TECHSPEC® HPr Series Fixed Focal Length Lenses

- High Performance Ruggedized (HPr) Versions of our HP Series Lenses
- Stability Ruggedized to Maintain Pointing Stability After Shock and Vibration
- Individual Optics Glued in Place to Reduce Pixel Shift

www.edmundoptics.eu/hpr-series

TECHSPEC® Rugged Blue Series M12 Lenses

- Ruggedized Versions of our Blue Series M12 Lenses
- Ruggedized to Reduce Pixel Shift and Maintain Optical Pointing Stability
- High Resolution Designs Optimized for Machine Vision Working Distances

www.edmundoptics.eu/ m12-rugged-blue

TECHSPEC® Ci Series Fixed Focal Length Lenses

- Streamlined Mechanical Designs of our C Series Lens
- Up to 7,5 MegaPixels, 2,8 μm Pixel Size Sensors
- Up to ⅔", C-Mount Lenses

www.edmundoptics.eu/ci-series

Edmund Optics® Imaging is a leader in imaging and machine vision technology. We create innovative products with the latest technology to solve customer application and challenges.

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