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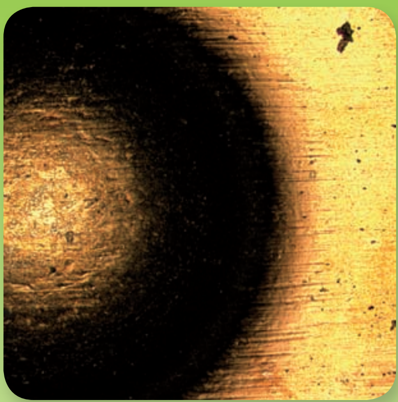
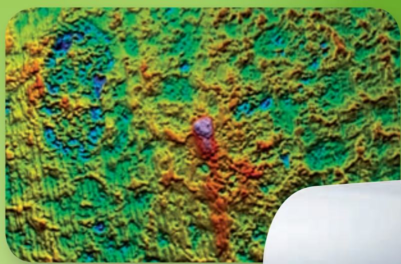
VISION ‣ AUTOMATION ‣ CONTROL

INSPECT





Focus on Quality

Microscopy in Industrial Applications

Automation with Laser Sensors

Optical Metrology

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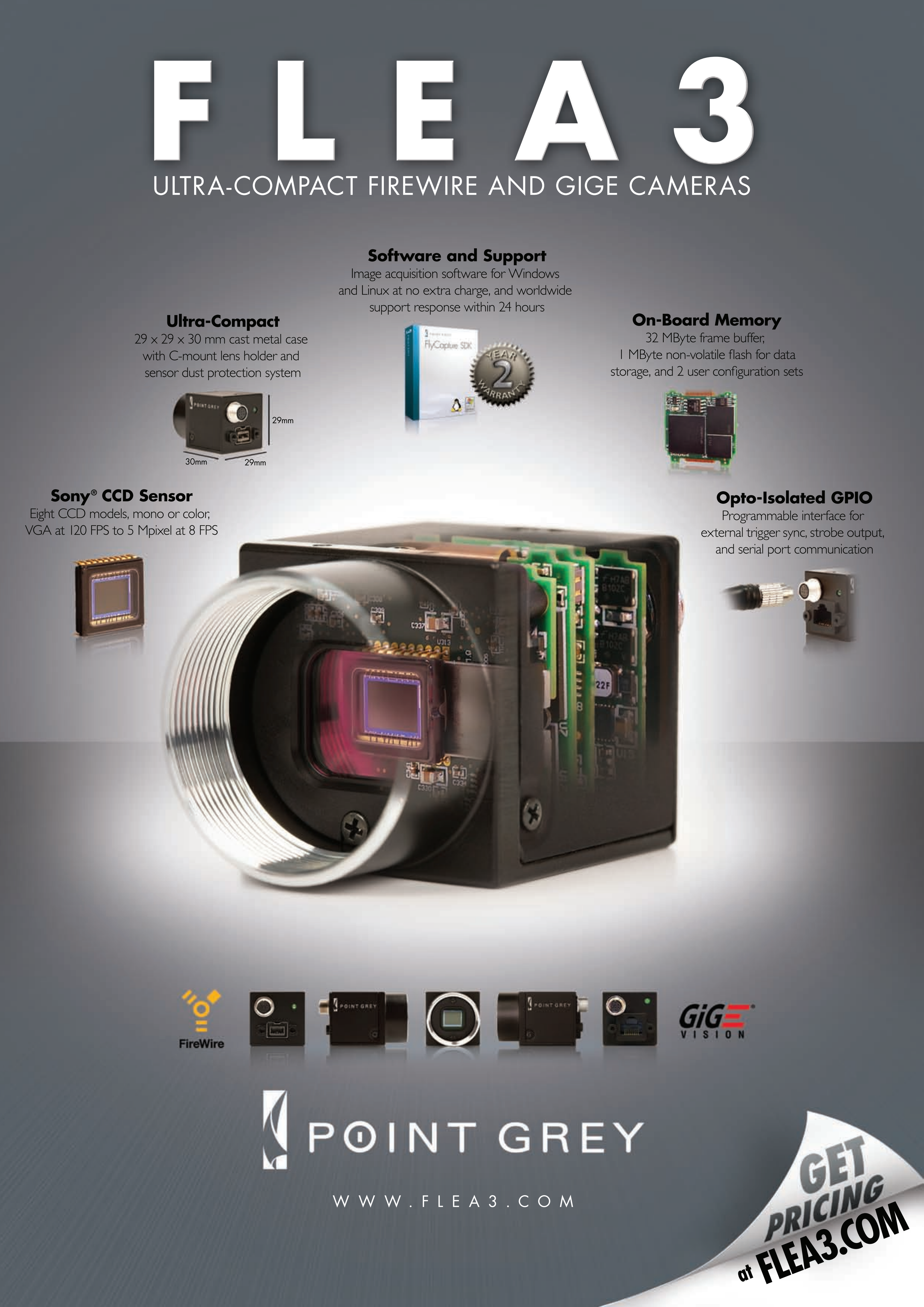
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From Healing and Destroying

It heals eyes and at the same time, it has the energy to cut through metal. It is able to write, to measure, to shape matter, and to transfer information: We are talking about the laser, a tool of contraries. As 50 years ago the U.S.-citizen Theodore Maiman finished the first working laser he probably had his own ideas of its use in the future. Otherwise he would not have spent his free time and threatened his former employer with his dismissal if he had not been allowed to continue his laser project. Not only Maiman, also the public in general was positive about the laser's usage. The Time Magazine described the laser as "the hottest topic in the field of state physics since the transistor." But Maiman's rubin laser did not fulfill the expectations: the laser materials were too impure, the power too little. The researchers were discouraged; the laser was mocked as an invention in search of an application. There were successful experiments, like the one where a laser pierced a steel girder, but the conventional solutions stayed outclassed. One billion US dollar, the laser should achieve 10 years later, forecasted the business press with enthusiasm in the year 1962. Turnover figures on which the economy had to wait for a long time. But today the everyday life is not to imagine without the laser technology: The laser beam reads the CD and DVD's data, supermarket cash points work on the basis of its invention. The laser light is even used for entertainment in so-called laser shows.

All the applications known today are possible due to the fact that laser beams are available in all desired wave lengths. For this, just the corresponding laser materials have to be chosen. Furthermore, laser beams can be generated as ultra short pulses. Especially in recent times, the pulses are getting shorter, the laser radiation covers the whole electromagnetic spectrum – from short wavelength X-radiation to long wavelength infrared. And meanwhile, they reach a peak power of some petawatt. But that's not the end of the laser project which started 50 years ago. At the moment, researchers of the National Ignition Facility (NIF) in Californian Livermore try to realize nuclear fusion reactions with laser radiation.

Dear readers, do you have the plan to visit this year's Control show, the trade fair for quality assurance? From May, 4 until May, 7, you can find there numerous laser applications, mainly in the special show "Contactless Measurement" (further information on page 50 onward). Combined with image processing, the laser is able to control the product's quality contact-free, e.g. with laser scanning sensors. In this issue, you can find further articles on laser applications, like the non-contact handheld gap and flush measurement for assembly processes in the automotive industry (page 48) or the innovative laser sensors for the wheel inspection developed by the company LMI (more on page 34).

I hope that you enjoy reading this issue. Let yourself be inspired and sink your teeth into your idea's realization, like Maiman. I am curious to see on which development we may report in 50 years from now.

Stephanie Nickl
Editor INSPECT

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VDS Vosskühler Celebrates Anniversary

The company VDS Vosskühler, located in Osnabrück, Germany celebrates in 2010 its 25th company anniversary. What started out as a one-man business in a garage in April 1985 can now look back on a very successful development during the past 25 years. Initially VDS Vosskühler focused on developing special image processors on VMEbus basis mostly being applied to image systems for medical application. Then later digital cameras had been added to the product portfolio. As early as 1991 the presentation of one of the worldwide first HDTV CCD cameras with 1,260 x 1,152 pixels had taken place.

Today the company develops, produces and distributes a wide range of state-of-the-art cameras for industrial and medical fields of application. Apart from digital cameras for visible light the product range also comprises X-ray detectors and infrared cameras, outstanding out due to a high image quality and reliability. VDS Vosskühler products are used worldwide in many diverse industries. Today, approximately 20,000 cameras are in use all over the world. In 2010 more highly innovative VDS Vosskühler products will be presented to the markets.

www.vdsvossk.de

Allied Vision Technologies Opens Sales Office in Singapore

Allied Vision Technologies announced that it founded a sales subsidiary in Singapore. The new company called Allied Vision Technologies Asia Ltd. is 100% owned by Allied Vision Technologies GmbH and will be in charge of expanding AVT's business in the Asia-Pacific region. This includes the management of existing distributors and setting up local technical support.

Boon-Keng Teng, Allied Vision Technologies' new Asia-Pacific Sales Manager, is looking forward to his pioneering job at AVT Asia: "It is a great challenge to build up a new sales organization in such a dynamic market environment," he said, "but Allied Vision Technologies is already a respected camera manufacturer in the region, and I know that I can count on the full support of the AVT group." Boon-Keng is an experienced professional with an engineering background coupled with sales and business development skills. He has been working in various positions in the microelectronics, consumer electronics and imaging industry in Singapore, India, Japan and Germany.

"The incorporation of AVT Asia is another milestone in Allied Vision Technologies' growth strategy," commented Frank Grube, President & CEO of the company. "The machine vision market in Asia-Pacific is huge and will be a major driver of our future growth. Thanks to its partnership with local distributors, Allied Vision Technologies has been very successful for years in that region. However, with our own subsidiary, we want to demonstrate our long-term commitment to the market and improve our service to our partners and customers."

Today, Allied Vision Technologies is represented by 11 distributors in 12 countries of the Asia-Pacific region. These partners remain in charge of the sales and support of AVT cameras in their respective countries, but they will now be locally driven and supported by the Singapore office.

www.alliedvisiontec.com

The Vision Show in Boston, USA

North America's Machine Vision Trade Show and Conference

The Vision Show, North America's machine vision event, is back to Boston, Massachusetts and will take place this year from May, 25 to 27. The leading machine vision manufacturers, system and component providers meet there in the Hynes Convention Center presenting their new products and latest technologies. In a separate application area the different components of a machine vision system and their interaction can be seen in a live demonstration. Visitors considering the purchase of machine vision technology can see for themselves how the corresponding systems save money and time while increasing products' quality. For visitors especially interested in new products, the fair organizer AIA (Automated Imaging Association) will set up the "New Product Presentation Theater." Soon, the time schedule will be published on the AIA website.

One day before the trade show's opening, on May 24, the corresponding conference will start. The conference offers tutorials and sessions for the beginner as well as for the advanced user. Taught by experienced vision professionals, the sessions' topics are varying from fundamentals of machine vision, lighting and optics, the latest advances in smart cameras and sensors to 3D vision solutions and system integration. This year for the first time, the conference participants are able to acquire the "Certified Vision Professional – Basic Level" certificate. This includes attending four specific basic tutorials and a final written exam. This is just the first of three CVP levels designed by the AIA to increase vision technology knowledge in the industry.

For visitors registered in advance, the Vision Show is free to attend. All exhibitors and visitors are invited, for a small fee, to join the Vision Networking Party in the Hard Rock Café near the Hynes Convention Center on May, 25.

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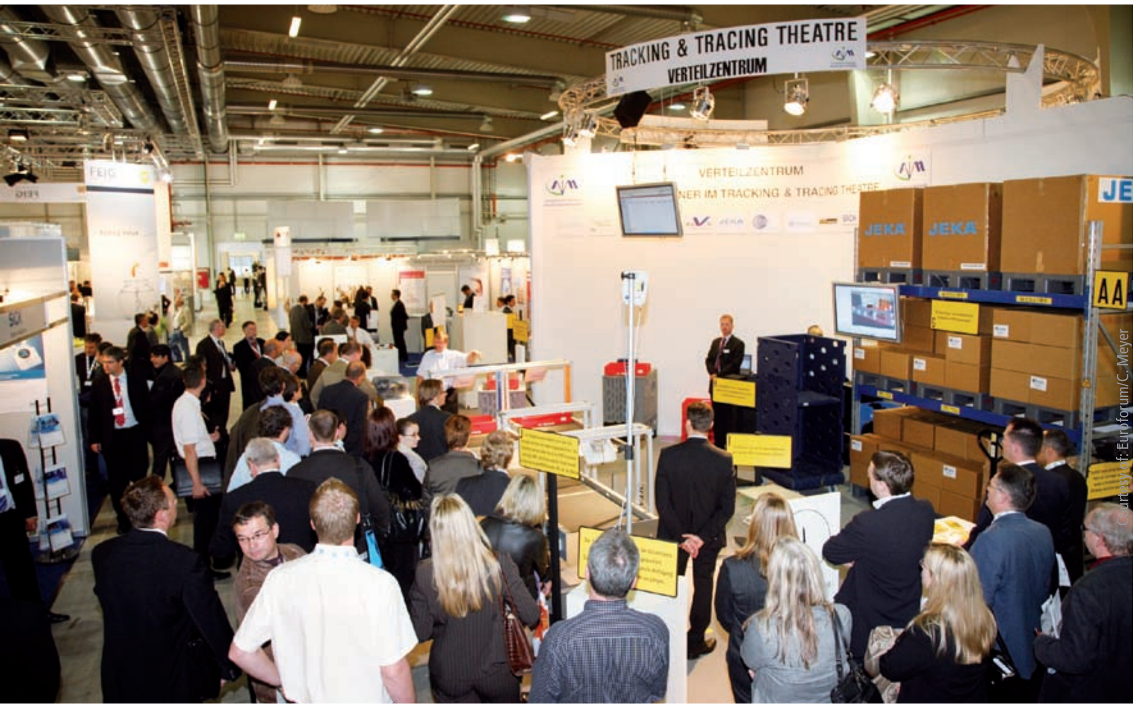
Euro ID in Cologne

Cross-sector European Trade Fair for Automatic Identification



The intersectoral European trade fair Euro ID is a central communication platform for the AutoID market. It takes place in Cologne, Germany, at the Expo XXI ground from May, 4 until May, 6. The Euro ID 2010 spectrum covers optical identification techniques (bar codes, 2D codes, 3D codes), electronic identification techniques such as RFID, sensor technology and GPS, as well as software systems (middleware, ERP connections). In addition, related technologies such as IT security and telematics will be showcased, as well as service offers, training and consulting for the entire field of automatic identification.

This year companies once again had the opportunity to submit applications for the "European AutoID Award," which will be conferred for the fifth time in 2010. Applications have been accepted in the categories "RFID," "Bar Code" and "Innovative Company." The award ceremony will be held during the Euro ID 2010 trade fair.

In addition to the award ceremony the fair organizer will hold a user forum. In a series of short technical presentations, experts will be providing practical and concise answers to questions around AutoID technology: What does the future hold for AutoID technologies and how can users interface their own systems with suppliers and customers? Trade show visitors have free entry to this user forum.

The tracking and tracing theatre (T&TT) is planned for 2010 again. The practical live scenario is organized by the industry association AIM and shows the usage of AutoID technologies in an area of 120 m^2. There, visitors can track the material flow in logistic chains from manufacturer or provider over distribution centers to production lines or track finished products. An extension of the theatre which includes AutoID assisted processes by the usage of automobiles is discussed in the moment. Several times a day, experts guide visitors about 30 minutes through the T&TT and explain the AutoID products and technologies live in the demonstrated processes.

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Polarizing Technics

Advances in Confocal Laser Scanning Microscopy

From silicon semiconductor manufacture and corrosion analysis, to even archaeological investigations: Surface metrology is rapidly emerging as a vital analytical technique to determine the materials' topology. This technique requires the use of a microscope able to accurately and repeatedly visualize even the minutest of details: a measuring confocal laser scanning microscope.

Schematic of the laser and brightfield light paths of the Lext OLS4000

Clear and precise images with a high-level of resolution are required for the analysis of surfaces properties. These images resolve successfully minute surface details so that they can be distinguished from other details within close proximity. A number of different technologies exist for achieving these aims. For example, surface profilers literally drag an arm over the surface of the material. Scanning electron microscopes require large samples to be broken up and need to be coated before being placed into the vacuum chamber. Not only do these instruments cause damage to the sample, but the SEM also requires a large amount of sample preparation. Confocal-based optical metrology instruments on the other hand are non-contact and the majority of samples can be placed directly on the stage with no preparation.

As such, Olympus developed an optical metrology tool in the form of a measuring confocal laser scanning microscope (mcLSM) which determines layer thickness, roughness and surface structures. The system uses a 405 nm laser with highly tuned optics to provide extremely high resolution (120 nm line and space). The mcLSM combines the ability to accurately image specimens in focus, with the non-contact capabilities of laser scanning technology. Therefore, this technique can successfully produce exceptionally clear and detailed optical images of samples that may have previously been difficult to resolve.

Polarization Instead of Fluorescence

Confocal systems used for optical metrology, have a different optical set-up to life science cLSMs. This is because there is no fluorescence excitation/emission and therefore the wavelength of the light impinging the surface of the sample is the same as that reflected back to the detectors. As a result, a dichroic mirror cannot be used to separate the illumination (excitation) and reflection (emission) pathways. Instead, the system uses polarization to separate the two pathways: Laser light by its nature is plane polarized and as it reflects of a surface the plane is changed to varying degrees depending on the surface materials and features. As a result, as the reflected light passes back up through the microscope it can be differentiated from the illumination light path. This is best achieved by using a polarizing beam splitter, which lets the illumination light through in one direction, but redirects the reflected light to the photomultiplier tube (PMT). To fulfill the requirements of confocal imaging the system must incorporate a pinhole in front of the PMT to block out of focus light. The PMT is then able to covert the photons of light into a digital image.

Aberration Correction

As light passes through lenses and prism, or is reflected of mirrors, its properties can change and as a result spherical wavefront aberrations are introduced which cause deterioration to the clarity of the image. The optics within the system is therefore designed to eliminate these aberrations in order to provide a sharp and focused image.

Laser confocal technology using a 405 nm laser provides an exceptional level of detail but lacks color information, which may be important in the interpretation of features on some samples. As a result optical microscopy systems use the same optics to generate reflected brightfield images which can be combined with the confocal image to provide high resolution full color images. That is the reason why the optics also needs to be corrected for chromatic aberrations (aberrations caused by the different transmission properties of different wavelengths through the lenses, prisms and mirrors).

Dual Pinhole Technology

The quality of the image generated in a mcLSM system is not only influenced by the optics, but also by the presence and size of the pinhole. The system is only able to produce digital images from the light that has passed through this tiny hole located directly in-front of the detector. Therefore the confocal effect is altered by changing the size of the pinhole – smaller pinholes exclude more light, whereas larger pinholes let more light and subsequently more out of focus blur pass. The smaller the pinhole though, the thinner the depth of field within each image and therefore if samples have very steep slopes there is not enough information within the optical slice to generate an image of the slope. That is why instruments, such as the Olympus OLS4000 Lext, have been designed in that way that they split the reflected light signal as it passes back through the polarized beam splitter into to equal light paths. One of these is directed towards a larger pinhole and the other towards a small pinhole. Each of the PMTs utilizes a different analogue to digital conversion circuitry suitable to the image information being collected. The resulting output from the two pinholes is combined and displayed by the software and the percentage contribution of each one to the image can be easily adjusted to provide the user with control over the final image. As a result, slopes of up to 85° can be clearly visualized and measured.

MEMS-based Laser Scanner

In order to produce a digital image, the laser light beam is focused in the XY plane and scans across the sample surface, line by line. The reflected light is then de-scanned by the same mirror. Two key properties of the scanner that can be optimized to provide superior system performance are the size and the speed of the scanner drive: The larger the mirror, the bigger the optical zoom possible, providing much more flexibility in imaging, especially when in live scan mode. Many mcLSM systems use galvanic mirror-based scanners which provide the accuracy required to generate the raster scan pattern at all different magnifications. More recently, micro electromechanical system (MEMS) technology has provided the capability to significantly increase the scan speed.

Roughness

A laser does not touch the surface to obtain roughness measurements and does not get stuck on adhesive or complex surface features, like traditional scanning cantilevers. mcLSM optical metrology instruments can be set to linescan such that the instrument measures the z displacement along a defined line in any xy direction. This gives the same roughness information as the traditional contact systems but in much less time. What is more, the confocal system can perform area roughness scans where the roughness of an entire area of the sample is measured. This is an emerging technique which provides a much better idea of overall surface roughness and corresponding standards have recently been introduced (ISO 25178 – Geometric Product Specifications [GPS] – Surface texture: areal).

Discussion

Optical metrology is a rapidly emerging technique within materials science. The mcLSM optical metrology systems, such as the Olympus Lext OLS4000, make it easier to image and analyze minute details of a surface. The use of specially designed optics removes the associated issue of wavefront aberrations, ensuring that a clear, precise image is obtained from every sample. Combined with dual pinhole technology, and an advanced high-speed MEMS laser scanner, clear visualization of even the most complex surface topology enables the measurement of ultra-fine surface detail.

Control: Hall 1, Booth 1512

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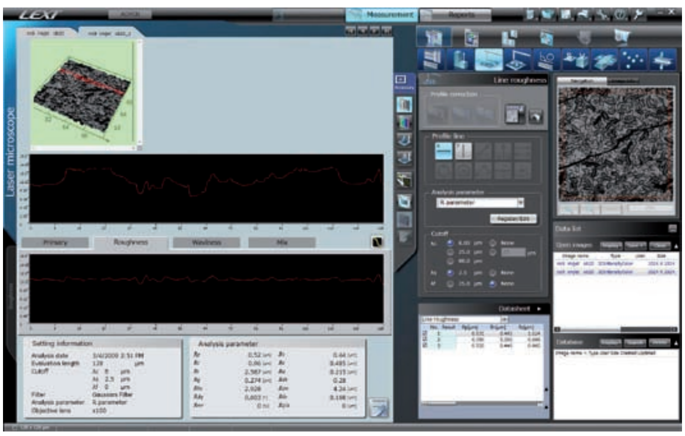
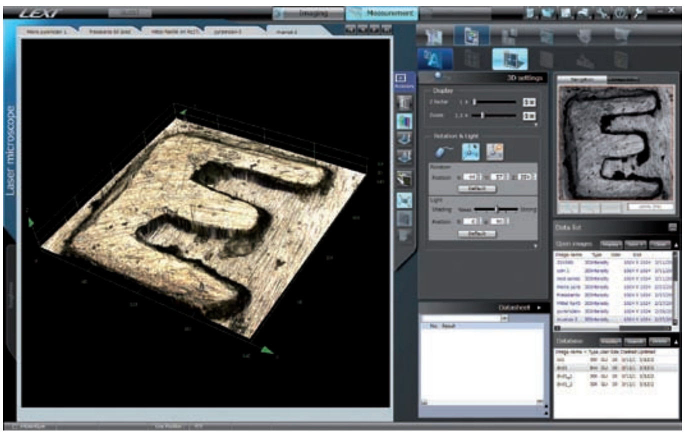


Line roughness on No9 inkjet, imaged and analyzed using the Olympus Lext OLS4000 at 100x



Coin topography with real color overlay (steep slope measurement)

Quality and Efficiency for the Factory Floor

24th Control: International Trade Fair for Quality Assurance

From May, 4 until May, 7, 2010, the Control, international leading trade fair for quality assurance, takes place on the premises of Messe Stuttgart, Germany. This year's focal point of the trade fair is energy efficiency in production. In an event forum, the Fraunhofer IPA highlights this topic. Further events, special exhibitions and new products presented at the Control, you will already find in the following overview.

Control 2010 presents itself as a leading trade fair with a look at the wider picture. Thus, the trade fair wants not only to showcase the international offerings for QA technologies, products, subsystems and complete solutions in a consistent fashion, but also to integrate the topic efficiency in the trade show's program. Quality assurance as well as energy and environmental management base on the same measurement data collected in the production. That's why fair organizer P.E. Schall has chosen the focal point: efficient use of resources in production by employing machine vision and optical measurement and testing technology. The Fraunhofer IPA adopts this focal point in its event forum (hall 1, booth 1602). There, the forum gives attention to the aspects of energy management, energy efficient machinery and plant equipment as well as energy measurement techniques with a combination of daily lectures, exhibits and practical presentations.

Special Show "Contactless Measuring"

This year again, the Fraunhofer Vision Alliance presents the innovative special show "Contactless Measuring." Still, new users of optical technologies sometimes react with reservation and uncertainty due to the completely different functional principle compared to mechanical measurement techniques. That's why the Fraunhofer Alliance shows selected exhibits in order to demonstrate construction principles, possibilities and limits of optical measurement. The special exhibition presents topics like 3D camera systems for object recognition and measuring or the inline quality assurance with 3D surface holography.

Furthermore, the Control hosts an exhibition forum where companies have the possibility to introduce themselves, their products or innovations in short lectures. In the theme park Quality Assurance in Medical Engineering, industrial providers and users from the health sector have the possibility to exchange experiences. Users are shown technical innovations, and on the other hand they explain about the special conditions the quality assurance is confronted with in the area of medical technology.
For the first time, the Vision Academy offers a free seminar at the Control. The topic is "Applications in machine vision – from specification to solution." The offer is directed at engineers and technicians who have so far no machine vision in use.

Innovations at the Control Show

In four exhibition days, the exhibitors showcase their news in the halls 1, 3, 5 and 7 of the new trade fair center in Stuttgart. The relevant topics are: measuring technology, material testing, quality assurance systems, analysis devices, and optoelectronics. Some of the highlights you can already find here in our trade show pre-view.

For applications in the micro system technology, like the cutting edge detection or the inspection of printing cylinders, **Alicona** (www.alicona.com) presents a new **sensor for optical 3D measurement in production**. The sensor is an outstanding tool due to its speed and high resolution at large measurement fields, including the z-axis. The sensor is based on the technology of focus-variation and enables form and roughness measurement of components.
☛ Hall 1, Booth 1612

Up to now, the concentricity of bevel gears or gear shafts with splines is determined by tactile measuring methods. For objective measurements for **concentricity properties**, **EHR** (www.ehr.de) provides a **laser triangulation sensor** which digitalizes the tooth area's 3D structure. The therewith measured 3D point cloud can be evaluated according to customer specifications. In order to achieve comparability with tactile measurement systems balls are put mathematically between the tooth edges. The comparability of both measurement principles ensures an increasing acceptance of the optical method.

☛ Hall 1, Booth 1624

Grinding and Finishing are important manufacturing methods to fabricate high-stressed function surfaces, like for rollers, motor shafts and rolling bearing rings. In order to monitor the process quality the surface is **inspected with respect to roughness, shape and waviness**. With the new optical Sensor OS500 and the rotational module RT1 from **OptoSurf** (www.optosurf.com), it is now possible to measure the concentricity in a range of µm and the waviness down to <0,05 µm precisely and fast in harsh conditions next to the manufacturing machine.

☛ Hall 3, Booth 3521

Also the company **Isis** (www.isis-sentronics.com) presents its new sensors for industrial inspection tasks: a **semi-automatic inspection system for interior spaces** which is available in four options, the I-Dex Series. Thus, interior spaces of free form objects as well as rotationally symmetric objects can be determined three-dimensional. Measurement parameters are amongst others diameter, concentricity, ovality, conicity, and coaxiality. Technical roughness data can be measured up to a minimal roughness of Rz = 0.5 µm.

☛ Hall 3, Booth 3310

The company **Automated Precision** (www.api-sensor.com) highlights at the trade fair the various fields of applications of its **mobile laser tracker**. The compactly designed system allows object's measurement with a range of 120 m without relocation but works as well from shorter distances. The tracker head can be tilt horizontally to +/- 320 degrees and vertically +80 to -60 degrees. With both angles and the measured distance the 3D measurement system calculates the coordinates.

☛ Hall 3, Booth 3104

Also **Faro** (www.faro.com) presents its laser tracker, ION. The **portable 3D measurement system** aligns effectively large components, devices and machines with high-precision. Furthermore, the company exhibits its laser scanner Photon which accomplishes area documentations, and measurements of large objects like factory buildings.

☛ Hall 3, Booth 3404

Kreon Technologies (www.kreon3d.com) showcases its established laser scanners Aquilon, Zephyr and Solano as well as the new Kreon Skiron, a compact and ergonomic scanner. Fully integrated into the Micro scribe desktop digitizers, this **laser scanner dramatically reduces digitizing time**. Its capability to accurately scan details with a high speed opens a wide range of applications. Combined to the Scantools 3D software, this complete package can combine traditional metrology and non-contact measurement in a perfect fit.

☛ Hall 3, Booth 3234

For the detection of surface profiles, **Breitmeier** (www.breitmeier.com) offers the **complete interferometry measurement station** WLI-Lab as well as the OEM measurement head for inline applications. These instruments provide results with measurement times faster than 1 s and resolutions in the nm range. The station is used in plants for surface profile measurements, in the machinery engineering for wear measurements, for step height detections of coatings, determination of roughness, and chip control in the field of semiconductors as well as universal instrument in the development process.

☛ Hall 3, Booth 3008

Accuracy in fitting and coplanarity of the connecting pins of plug connectors are extremely important. Therefore, **SAC** (www.sac-vision.net) presents an inline 3D inspection system **for a 100% control of plug connectors**. With this system, defects can be already detected during the production. The system is based on the principle of fringe projection with a pattern projection unit as kernel. It features a high measuring accuracy at simultaneous short acquisition time, and minor mechanical input for the specimen's positioning.

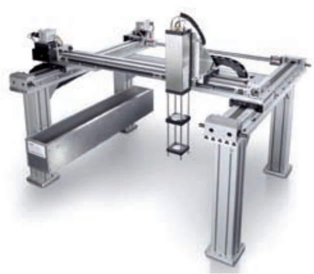
☛ Hall 1, Booth 1637

The focal point of **Mahr's** (www.mahr.com) exhibition is the **practice-oriented quality assurance in production** – with

high-end measurement systems and manual measurement techniques. Measurement solutions will be presented which are conceived for harsh production environments and inspect reliably precision tools in continuous 3-shift operations. This is accomplished by the surface measurement device of the MarSurf-X series which now is also able to determine lengths.

☛ Hall 3, Booth 3102

The fully electronical 3D terahertz imaging system SynView-Scan developed by **Synview** (www.synview.com) **enables fast and robust three dimensional measurements** based on the Terahertz profilometer's measurement head. Above all, composite material which consists of glass fiber boards, foams, papers and plastics can be inspected in depth. This allows the detection of hidden water ingresses or water inclusions, defect adhesions or structural defects. The measurement time ranges between less than 1 s up to 10 s, depending on the system configuration and the application.

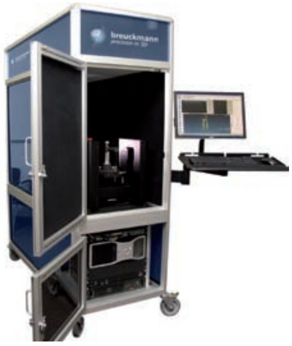


☛ Hall 1, Booth 1612

Geomagic (www.geomagic.com) presents **new versions of its 3D software** for reverse engineering and quality inspection: Geomagic Studio 12 and Geomagic Qualify 12. Geomagic Stu-

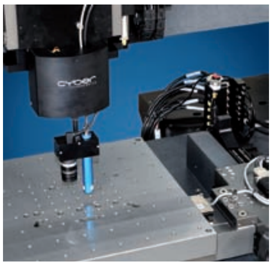
dio 12 is the only 3D scanning software to provide direct parametric model exchange with all leading 3D mechanical CAD packages. The latest version includes new features for accelerating workflow, including Autosurface, which creates a high-quality IGES file from a polygon mesh at the push of a button. Geomagic Qualify 12 includes an entirely new report generation and publishing engine that enables coloured and annotated 3D models to be embedded directly in PDF.
☛ Hall 3, Booth 3218

The company **Breuckmann** (www.breuckmann.com) showcases its new measuring system b-Inspect 3D at the Control. The completely self-contained system works with the stereoScan 3D-HE sensor as well with a swivel and turning unit. In shortest time, it measures the whole object's geometry and even difficult surfaces without the need for spraying or matting. With the **robust swivel and turning unit**, the data are captured completely. In the production area, the measurement system is built vibration-isolated.



☛ Hall 7, Booth 7236

CyberTechnologies (www.cybertechnologies.com) developed its **surface measuring devices especially for large scanning areas**. The non-contact devices CT 350S and CT 600S possess a user friendly interface and a comprehensive 2D and 3D analyzing software. While the CT 350S strength is the large measurement area in z direction through the closed loop 200 mm z-axis the CT 600S measures large and heavy components very precisely. The corresponding Scan Suite software combines system control, data collection and data analysis. This ensures that all common 2D and 3D analysis functions can be used.



☛ Hall 7, Booth 7406

The new **Keyence** (www.keyence.com) CV-5000 vision system offers high-speed image processing for any production line. Up to four 5 million-pixel cameras capable of transferring images simultaneously can be used to allow high-definition inspections of up to 20 million pixels. This series also allows simultaneous use of several other camera types. Users can **select from a lineup of 14 different models**, including ultra-compact standard and mega pixel, as well as high speed standard and high speed 2 mega pixel which can transfer images in 4.7 ms and 29.2 ms, respectively. Each camera type is available in both color and monochrome models. The vision system makes it easier for users to fine tune their program tolerance and settings to improve yield rates.
☛ Hall 1, Booth 1431

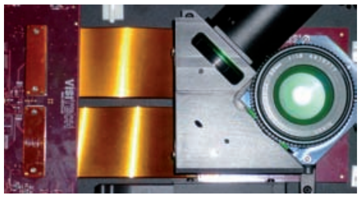
Imagechecker P400XD is the new high-performance machine vision system from **Panasonic** (www.panasonic-electric-works.com). It is developed **especially for complex inspection tasks** whereby an extremely fast and precise control with multiple cameras is required. The corresponding turnkey system is based on a powerful and expandable industrial PC with a 19" format. As a standard, the Imagechecker supports the connection of two CCD cameras. Today, there are four different camera types available; the maximum resolution is 5 mega pixels per camera at the moment.

☛ Hall 1, Booth 1514

In order to offer telecentric lenses for cost-intensive applications, **Sill Optics** (www.silloptics.com) developed **a new lens series with good optical properties**. This series consists in the moment of four lenses with the common magnification values of 0.2x, 0.25x, 0.33 and 0.5x. These lenses possess a consistently working distance of 89 mm. Also, the overall length of the lenses is the same to ensure the interchangeability. With a distortion less than 0.25 % and a NA higher than 0.012, the lenses can be used for most of the standard applications.
☛ Hall 5, Booth 5014

Edmund Optics (www.edmundoptics.com) broadens their ReflX objectives brand with the acquisition of the Ealing-Beck reflecting objectives product line. With these 18 new objectives, the company showcases **30 different options of its ReflX Objectives** at Control. They are all free from problems of chromatic aberration and material absorption associated with standard microscope objectives. Their finite conjugate design and RMS threading integrate easily into many objective setups and are available in three coating choices. Ideal for applications requiring high throughput and high resolution, these mirror-based objectives provide excellent beam delivery or color corrected image quality for a number of applications, including FT-IR spectroscopy and microscopy, semiconductor inspection, and laser etching.
☛ Hall 7, Booth 7122

Also **Visitech** (www.visitech.no) extends its portfolio. This year's Control show is the venue to **introduce the brand new light engines** Luxbeam LE4910H for NIR and LE4710H supporting the IR range up to 2,700 nm for industrial micro display applications. They support the full range of display sizes from 0.55˝XGA (1,024 x 768 pixels) up to 0,95˝ 1,080p (1,920 x 1,080 pixels) and allow implementation of almost any light source. Key features of the light engines are compact size, excellent light efficiency and brightness uniformity across the display.



☛ Hall 1, Booth 1327

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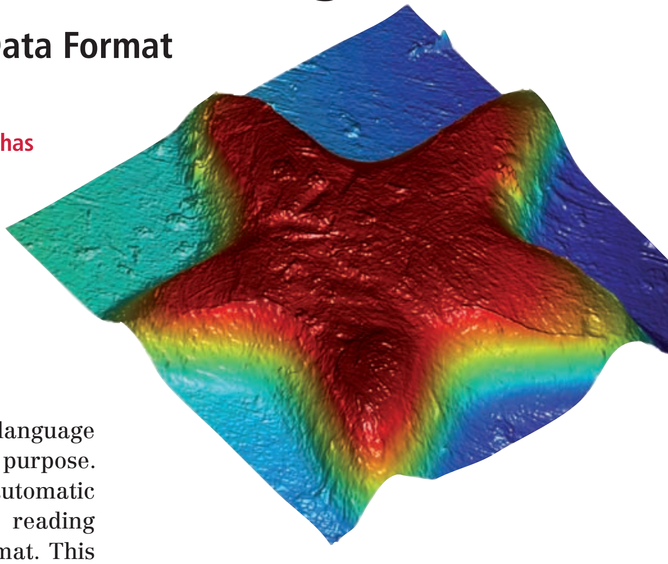
Calendar

DATE	TOPIC · INFO
27.–28.04.2010 Birmingham, UK	**VTX Vision Technology Exhibition** The leading exhibition for vision technology in UK www.devicelink.com/expo/advuk10/
27.–29.04.2010 Moscow, Russia	**VIT Expo** Vision & Imaging 2010 is devoted to machine vision www.rual-interex.ru
04.–05.05.2010 Duisburg, Germany	**5th Fraunhofer IMS Workshop: CMOS Imaging – Low-Light Imaging** International workshop on CMOS imaging, focus on low-light imaging www.ims.fraunhofer.de
04.–06.05.2010 Cologne, Germany	**Euro ID** International trade fair and science forum for automatic identification www.euro-id-tradefair.com
04.–07.05.2010 Stuttgart, Germany	**Control** The world's leading trade fair presents QA solutions with a future www.control-messe.de
25.–27.05.2010 Boston, MA, USA	**The Vision Show** North America's leading showcase of machine vision and imaging components and solutions www.machinevisiononline.org
08.–11.06.2010 Munich, Germany	**Automatica** International trade fair for automation and mechatronics www.automatica-munich.com
09.–11.06.2010 Yokohama, Japan	**ISS 2010** The image sensing show exhibits practical image processing products and technologies widely used www.adcom-media.co.jp/sensing/eng
15.–18.06.2010 Frankfurt, Germany	**Optatec** International trade fair for optical technologies, components, systems and manufacturing www.optatec-messe.de
12.–15.07.2010 Las Vegas, NV, USA	**IPCV'10** The 2010 international conference on image processing, computer vision, and pattern recognition www.worldacademyofscience.org/worldcomp10/ws/conferences/ipcv10
31.08.–02.09.2010 Dresden, Germany	**International X-ray CT Symposium** Symposium on high-resolution computer tomography www.phoenix-xray.com
13.–16.09.2010 Stuttgart, Germany	**Microsys** Trade fair for micro and nano-technology www.microsys-messe.de
27.–29.10.2010 Beijing, China	**Vision China 2010** China international machine vision exhibition and machine vision technology & application conference www.visionchinashow.net
09.–11.11.2010 Stuttgart, Germany	**Vision** International trade fair for machine vision www.vision-messe.de
09.–12.11.2010 Munich, Germany	**Electronica** International trade fair for components, systems, applications www.electronica.de
21.–24.03.2011 Chicago, USA	**Automate** Automate is the new International Robots, Vision & Motion Control Show

Find these and more events with detailed information at **http://www.inspect-online.com/en/events**

Free Interchange of 3D Measuring Data

X3P – a Flexible, System-independent Open Source Data Format

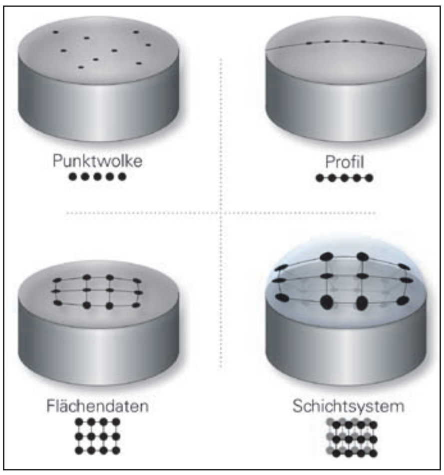


Until now interchange of 3D measuring data between various measuring systems has presented users with great challenges. To solve this problem the openGPS consortium has now developed a flexible 3D data interchange format for surface profiles, which allows smooth transfer of 3D data from various measuring systems while maintaining its traceability.

When designing a new data format it is necessary to find a reasonable compromise between the format capability and its simplicity of use. The X3P format (XML 3D Point Format) is therefore limited to use as a standardized interchange format for 3D point data. In developing X3P the openGPS consortium, whose objective was to create reference implementations of standardized algorithms for calculation of surface parameters, used existing standards to the extent possible, without taking on their weaknesses. The principles for the data format design were the tried and tested XML language, the ZIP archiving format and the DIN/EN/ISO Standard 5436-2 published in 2001.

The XML language allows complex hierarchical information to be structured in a unique manner and saved in a form legible for humans. With its aid it is possible to express data types and relations of an XML file's elements in a language designed specifically for this purpose. Special software tools allow automatic generation of the program for reading and writing the new XML format. This avoids practically any programming errors during implementation and allows automatic verification of the data generated.

The ZIP format has already proven itself as a container for numerous data formats, even though users frequently are not aware of it. The contents of such files can be displayed by all applications capable of unpacking the ZIP files. The compressed documents are very compact and can consist of a number of individual files packed together in one file. This is a practical method of storing complex document structures.



Vicinity relationships of 3D point data: a) unordered point cloud, b) profile line with one dimensional vicinity, c) areal point data with two dimensional vicinity, d) layer system with three dimensional vicinity.

Data Storage in X3P

X3P serves for storing and exchanging 3D measuring data. This data is present in the form of coordinate triplets describing measuring points as linear profiles or plane data records for a surface.

The simplest arrangement is a point cloud, consisting of an unordered set of 3D points. Their vicinity relation is unknown and they are distributed in an arbitrary manner in space. Such data is, for instance, generated by coordinate measuring machines.

Line profiles consist of points, each of which has a specific predecessor or successor. The line, on which the points are located on the surface, does not necessarily have to be straight, it can have any shape. However this has no effect on the sequence of points. Every point has a specific predecessor and successor. Profile data are, for example, generated by mechanical contact stylus instrument profilometers or optical point sensors.

The highest order of 3D points is the representation of a surface using a projectable matrix. This type of data can be generated by surface-measuring profilometers as well as point-sensing systems. In this case every point has four direct neighbor points, like each field on a chessboard. It is important to consider this vicinity relation separately from the spatial position of the points. It is not necessary for the points to be positioned in space exactly at the centre points of the chessboard's fields; they can deviate from this position as far as the proximity relationship stays clear. The image of a fishing net can help visualize this concept. Even when the net is distorted or tangled, it is possible to reach the next adjacent knot along the same filament.

Many optical and particularly tomographic measuring systems can measure surfaces with multiple layer coatings and generate a separate 3D profile for each layer. In this case the points in a profile no longer have only four adjacent points in the plane, but in addition one adjacent point each, above and below. The data is therefore organized in the form of a data cube, instead of a matrix.

Basis Information from Metadata

A data record does not consist only of pure 3D point data; its quality is influenced to a significant degree by the supplementary metadata assigned to it. This can be information on the type and serial number of the measuring equipment, its calibration and the time of measurement. Knowledge of the measuring equipment used is frequently essential for interpretation of the measurement. For this reason X3P offers the possibility of saving a comprehensive metadata record derived from ISO5436-2. In addition to the creation date and time for the data record, this also indicates whether a contacting or non-contacting type of measurement was used or even if the data originated from software simulation was not created with actual measurement. It also includes the serial number and type of measuring instrument as well as the time it was last calibrated, to guarantee the traceability of the data.

Freeware

The openGPS consortium follows the usual method of standardization in developing the X3P format: A description of the format is developed in text form in the standardization committee and should finally be adopted as a valid international standard. The usual method would then be for each measuring instrument software supplier to develop their own software implementation based on this standard. However, practical experience shows that the implementations by the various suppliers are seldom identical. The consortium therefore decided not only to define the X3P format as a standard, but also to simultaneously provide it at as free software in a reference implementation. This eliminates the necessity of separate implementation by each company, so that all manufacturers at least use identical implementation. Finally freeware eliminates the risk of long-term dependence on a software supplier, because, if necessary it is possible for a company to manage the X3P module itself.

Availability and Applications

The current release of the X3P software is version number 0.2beta and is available on the openGPS Website at www.opengps.eu. To date, examples of X3P have been implemented in measuring instrument software from NanoFocus, Alicona and Mahr to gain initial experience in practical use. Moreover a Matlab integration is available, which should be interesting particularly for universities.

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Radiant Presence

Optical Metrology Basics: Radiometry

Radiometry provides methods and quantities for the characterization of the intensity of radiation with emphasis on applications in optical metrology. Whenever the signal in an optical sensor in combination with the associated lighting system must be estimated, the quantities and concepts of radiometry come into play. Should you like to know whether ten LEDs will produce a sufficiently high lighting level in the field of view to saturate your camera signal, it my be a good idea to brush-up your knowledge about radiometry. The same holds true when you look at the data sheets of light sources or lighting systems from different manufacturers.

Radiometric Quantities

Radiometric quantities evaluate the energy of radiation. In this article, the focus is on applications in optical metrology. We thus narrow the field by looking at the visible spectral range, the UV and the near infrared, where radiation may be picked up with photodiodes, CCD- and CMOS-detectors. We assume the radiation to be unpolarized and incoherent, which means that the wave nature of radiation does not show up and interference phenomena are excluded. To further simplify the situation, let us first imagine a light source with small spectral bandwidth. A good example of a source which meets these requirements is a LED with emission of red light of 620 nm, e.g., which might have a spectral bandwidth of 20 nm. Packed into a plastic lens with a diameter of maybe 5 mm, the light emission might be bundled into a cone with a full angle of 20°. If you look at such a LED from a large distance, from 50 cm, e.g., the light seems to be emitted from a very small area, and we may treat the LED as a point source. Radiometry provides the tools to estimate the signal for a photodiode or a camera which is placed in this radiation field on the basis of just a few elementary quantities.

One elementary radiometric quantity is the total radiant energy Q of a light source. Q is the energy emitted into and integrated over all directions within a certain time interval. An example is the radiant energy of a strobe light source emitted within a single strobe. Q is an energy measured in the unit Joule. Usually, the radiant flux Φ will be specified rather than Q. Φ is the rate of change of Q with time. The radiant flux, being the total radiant energy per time interval, is measured in the unit of power, Watt, and may be viewed as the radiant power transported through the diameter of a bundle of rays. Total radiant energy Q and radiant flux Φ are conserved, which means they remain constant along the direction of propagation of the radiation as long as no energy is lost by absorption, scattering or refraction at boundaries. The manufacturer of the LED might thus specify a radiant flux of 10 mW, e.g., for a certain current and temperature, within an angle of emission of 20°. No matter how far away you are from the LED, you will always measure a flux of 10 mW flowing through the diameter of the bundle of rays emitted by the LED. Since the diameter will increase with increasing distance from the source, however, the radiant power will be distributed over an increasing area. This situation gives reason to define the flux density E, which is also called the irradiance. E is the radiant flux Φ related to the area A illuminated by the radiation:

$$E = d\Phi/dA$$

E is measured in the unit W/m². The sun, e.g., produces an irradiance of 1350 W/m² in space at the orbit of the international space station ISS. Our example-LED, on the other hand, shining at a piece of white paper at normal incidence in a distance of 50 cm, will produce a circle of light with a radius of 8.8 cm, which means an illuminated area of 244 cm², resulting in an mean irradiance of 10 mW/244 cm², roughly 0.4 W/m². Irradiance is a differential quantity with reference to area and may thus be given for every single point of the radiation field. Multiplication with the area dA of a detector or a pixel probing this radiation field gives the radiant flux dΦ upon this

area. In general, on an illuminated surface, e.g., the irradiance will vary with position.

Photon Flux

The irradiance is well suited to describe the radiometric properties of a bundle of rays at a certain point in the optical path. Since radiant flux is conserved and an optical system basically just shapes the geometry of a bundle of rays, the flux can be tracked from the light source all the way to the detector plane, and the irradiance at the detector plane may be computed. Once the irradiance at the optical sensor or the detector array of a camera is known, the signal can be estimated. Photodiodes, CCD- und CMOS-sensors utilize the photoelectric effect for conversion of photons to electrons. The signal is a photocurrent or a total charge accumulated within a certain time interval. When absorbed within the detector material, every photon produces a single electron at most. The probability for a photon to release an electron is the quantum efficiency. A good data sheet will specify the quantum efficiency as function of the wavelength of the incoming radiation. Quantum efficiency may thus be quantitatively considered in an estimation of the signal, if necessary. By far more important, however, is the fact that the detectors mentioned above do not primarily detect radiant energy, but convert single photons to single signal electrons. As a consequence, it is more important to look at the number of photons hitting the detector rather than stare at the radiant energy absorbed. Needless to say, there is a close relationship between these two fundamental quantities. A photon with wavelength λ carries the energy:

$$E_{photon} = hc/\lambda$$

with h denoting Planck's constant and c the velocity of light. In optical metrology, the unit "electron volt" (eV) is preferred against Joule, since values for photon energies measured in Joule are quite small and unhandy. The electron volt is the product of the elementary charge and the unit Volt for the electrical potential difference with 1 eV equal to 1.6×10^{-19} J. When calculating photon energies, after some weeks you will have learned the value of the product hc by heart and realize that the energy of a photon with wavelength Φ simply is:

$$E_{photon} = (1240/\lambda)\ \text{eV} \times \text{nm}$$

1240 divided by the wavelength measured in nm results in the photon energy measured in eV. An IR-photon at 1240 nm, e.g., carries the photon energy of just 1 eV. A red photon at 620 nm as emitted by our example-LED has the energy of 2 eV, whereas a blue photon at about 413 nm provides an energy package of 3 eV. As a consequence, radiation at longer wavelengths with the same amount of total radiant energy is made up by a larger number of photons than radiation at shorter wavelengths. The bundle of rays from our example-LED at 620 nm and with a radiant flux of 10 mW pushes the enormous amount of about 3×10^{16} photons per second through the diameter of the beam. For a 10 mW-LED at 413 nm, however, the number would be only 2×10^{16} photons per second, and the signal would decrease to 67 % of the signal at 620 nm, taken for granted the same quantum efficiency at these wavelengths. For an estimation of the detector signal the number of photons N and the photon flux dN/dt are key parameters. The photon flux can be calculated from the radiant flux:

$$dN/dt = \Phi/E_{photon}$$

It should be evident that this relation holds true for monochromatic radiation only and must not be used for light sources with a continuous spectrum. The value of 1350 W/m^2 for the solar irradiance at the ISS, e.g., can not simply be converted to a value for the photon flux per unit area, since solar emission is continuous with respect to the wavelength distribution and contains photons from the UV through the colours of the visible range and up into the infrared. The photon flux can only be calculated when the spectral distribution of the solar emission is precisely known and taken into account by integration over the photon fluxes of the spectral components. With varying spectral distributions, as in applications in the public domain, where daylight varies significantly with the seasons and during a day, the estimation of a detector signal becomes complicated. Even lighting systems with modern white LEDs in a controlled environment provide much more challenging radiometric calculations due to the continuous spectrum of emission than small-band LED-units.

Radiant Intensity

To wrap up this introduction, another radiometric quantity should be mentioned, which is of some importance for the comparison of light sources. Our example-LED radiates 10 mW into a cone within an angle of 20°. Without focusing lens, the radiant power would be emitted into the full half space above the chip. This would drastically reduce the irradiance. At a certain distance, 50 cm, e.g., the irradiance E would not any longer amount to about 0.4 W/m^2 as calculated above, but much less, since the total radiant energy now will be distributed over the surface of a half sphere with a radius of 50 cm rather than over the base of a cone with a radius of about 8.8 cm at a distance of 50 cm. Thus, a quantity taking into account the divergence and the consequences for the energy flow within the emitted bundle of rays, but independent from the distance from the source would be quite helpful. This radiometric quantity is the radiant intensity I, defined as the radiant flux dΦ per solid angle dΩ. The solid angle describes the cone cut out of a sphere, when the tip of the cone is in the centre of the sphere. To quantify the solid angle, take a sphere with radius r and calculate the area A of the cap cut out of the surface of the sphere by the cone defining the solid angle. The solid angle is then given by $\Omega = A/r^2$ with the unit steradian (sr). This concept is analogous to the measurement of plane angles as arc length divided by radius of a circle with the unit radian (rad). The solid angle for a full sphere thus will be equal to the surface area of a sphere with radius r divided by r^2, that is $4\pi r^2/r^2 = 4\pi$ sr. For a half sphere, the solid angle is 2π sr, and for our example-LED the solid angle of emission will be about 244 cm^2/50^2 cm^2, which is roughly 0.1 sr. For small angles the solid angle is approximated by $d\Omega = dA/r^2$ with the area dA perpendicular to the radius instead of the spherical cap, in our case just the plane base of the cone. The mean radiant intensity for the example-LED amounts to I = 10 mW/0.1 sr = 0.1 W/sr. Since the radiant intensity is a differential quantity with regard to the solid angle, it can be given for every single point of the radiation field. Multiplication of I with the solid angle captured by the detector or the pixel results in the corresponding radiant flux or radiant power illuminating the device. In contrast to the irradiance, the radiant intensity of a point source will be constant for a light bundle propagating free, regardless of the distance from the source, whereas the irradiance decreases by 1/r^2.

Photometric Quantities

LEDs are often specified by the radiant intensity on the symmetry axis of the emission cone as a figure of merit. The unit for this quantity is W/sr or sometimes, within the visible range, candela (cd). When comparing two LEDs, it should be kept in mind that the divergence of the emission strongly influences the value of these quantities. Should the manufacturer be able to develop a lens on top of the LED-chip which decreases the angle of emission by the factor 2 from 20° to 10° with the same total radiant energy, the radiant intensity will increase by the factor 4. Although the new LED will appear to be four times better, it will provide the same amount of radiant power on a target as its predecessor. With fixed distance from the LED, however, the radiant power will be distributed to a smaller area of the target. This may be a benefit for some applications, but may be irrelevant for others. Further irritations arise from the habit of some manufacturers to specify the “intensity” as luminous intensity with the photometric unit candela (cd). Luminous intensity is equivalent to radiant intensity, but weighted with the response of the human visual system to optical radiation. For optical metrology applications like in industrial image processing or automation human visual sensations usually are irrelevant. The photometric analogon to the quantity irradiance, which is then weighted with the response function of the human visual system, is the illuminance with the unit lux (lx). Sometimes, you will find data sheets for cameras specifying the sensitivity with the somewhat awkward entry “0 lx“, which just means that the camera will produce a signal under infrared illumination. Since radiation in the IR is not visible for the human eye, the photometric evaluation of the intensity will result in an illuminance of 0 lx, no matter what the value of the radiometric quantity irradiance with the unit W/m^2 of this radiation field may be, even if it amounts to 10 W/m^2. For monochromatic light sources, in the visible range the photometric quantities can be converted to radiometric quantities with reference to the standardized sensitivity curve of the human eye. For light sources with continuous spectral distribution of the emission, there is no general means to convert from photometric to radiometric quantities. If such a conversion is possible at all, it must be based on precise knowledge of the spectral distribution.

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[2] Pedrotti, Pedrotti, Bausch, Schmidt, Optik, Prentice Hall 1996, p. 29 ff.

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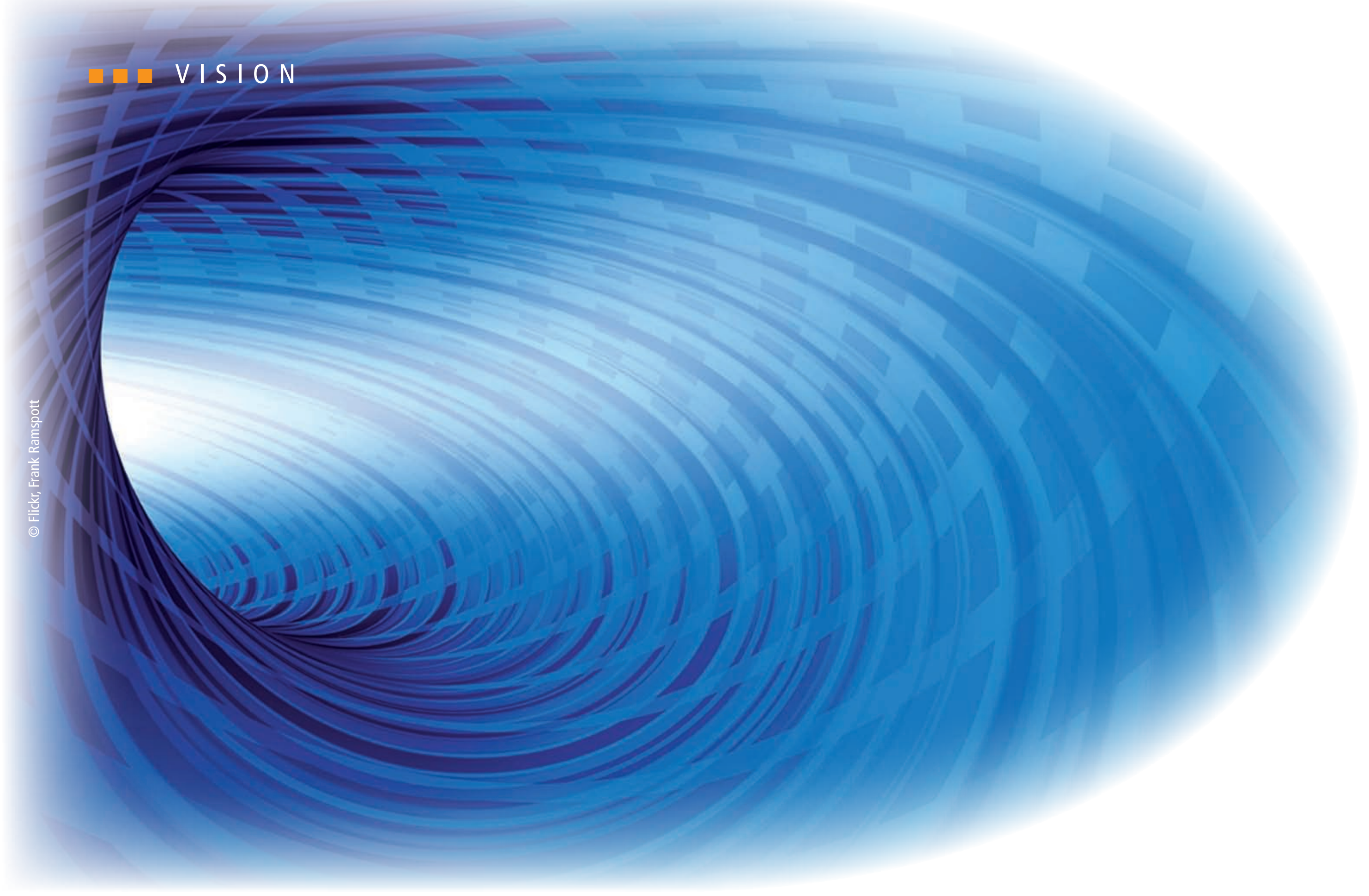

Extended Range, Lowered Cost

Next Generation Camera Interface: HSLink

Continual growth in the bandwidth requirements of vision system cameras has prompted the creation of a new camera interface standard targeting wide applicability at lowered cost. The HSLink interface takes key features of Camera Link and adds enhancements to match the needs of modern machine vision systems. Initially developed by Dalsa, the HSLink interface is now in the process of becoming an open industry standard.

With increasing resolution and faster frame rates, cameras for machine vision systems have steadily increased their need for bandwidth. Many cameras are now available that send more than 1 Gbyte/second to a frame grabber or image processor. The popular Camera Link interface, however, tops out at 850 Mbytes/second and 10G Ethernet interface can only manage 1.2 Gbytes/second. Extending either of these interfaces through increased parallelism will prove a costly option.

Scaling up to 6 Gbytes/sec

To address this shortfall, Dalsa has developed a new interface – HSLink – that can scale up to 6 Gbytes/second. The intent in developing HSLink went beyond attaining simple performance increases; however, it sought to address a wide range of vision system developer needs in terms of functionality, development costs, and service life. Dalsa also seeks to evolve HSLink into an open industry standard and has proposed that the Automated Imaging Association's Camera Link Committee take over the standards development process.

Long-term and Cost-effective

Two fundamental principles guided the development of HSLink. One was to ensure that the standard could evolve to meet the needs of vision systems for decades to come. The other was to make the interface easy to implement in a cost-effective manner for a wide range of camera systems from 100 Mbyte/s to 6Gbyte/s, line scan to CMOS windowed area array. The technical details of HSLink reflect these principles.

Beyond Bandwidth

HSLink's top-level protocol builds the four Camera Link message types – trigger, CC lines with expanded functionality called general-purpose I/O (GPIO), serial command channel, and video data – into a single prioritized stream. The camera's or frame-grabber's Camera Link Signaling Layer connects directly to an HSLink IP core, which in turn drives the PHY layer hardware (fig. 1). This re-utilization of Camera Link signals helps ease migration to HSLink systems by design teams already familiar with Camera Link.

The IP core does more than simply replicate Camera Link functionality onto a different cabling system, however. It also implements reliability and utility extensions. One critical reliability extension is support for hardware-based error detection and data resend. The hardware basis minimizes buffer memory requirement and allows the full interface to fit within an FPGA without needing external memory, minimizing implementation cost.

A second reliability feature is the utilization of two-of-three voting for critical real-time control messages that cannot tolerate a resend. The trigger, GPIO, and handshaking commands are each only a few bytes long. HSLink sends the command data three times within a message and the receiver compares the three data sets to detect and correct any single-bit errors in the message.

Added utility features include integrated real-time triggering (3.2-nanosecond jitter) that eliminates the need for a separate trigger cable. The protocol also supports data forwarding, which allows multiple frame grabbers to connect to a single camera and share the data stream. This feature simplifies the use of multi-processing to handle high-bandwidth camera data. The protocol also supports the insertion of intermediate devices between the camera and frame grabber, such as data concentrators. The protocol supports connecting as many as 64 cameras to a single frame grabber.

Physical Layer Supports Industry Standards

The HSLink physical layer (PHY) utilizes industry-standard serdes devices with 8b/10b encoding. This approach provides several benefits. One is lowered implementation cost; device developers can choose from a wide range of supplier options without needing to worry about interoperability with products from other vendors. The use of 8b/10b encoding also allows HSLink to have a longer reach than Camera Link. Stock serdes devices readily support cable lengths of at least 15 m, with 20 m common.

The HSLink interface was designed for scalability, allowing it to provide a consistent, cost-effective control interface for cameras with bandwidth needs below 300 Mbytes/second to as high as 6,000 Mbytes/second. Entire camera families can utilize HSLink effectively, simplifying vendor development and support efforts as well as system integration, maintenance, and upgrading. The use of standard serdes devices also decouples the protocol from the physical layers. This decoupling ensures that HSLink will readily scale to higher bandwidths as serial interfaces evolve, such as migration to optical fibers.

The currently-defined cabling for the HSLink interface is also scaleable, allowing system integrators to minimize cable costs for a given installation. An HSLink connection provides a 300 Mbyte/second uplink control channel from frame-grabber to camera, a similar downlink control channel from the camera, and from one to 20 300-Mbyte/second video data lanes. The lowest-bandwidth implementation of HSLink allows use of a single InfiniBand cable (two twisted pairs) as a low-cost solution, with one twisted pair carrying both the downlink channel and the video lane. The physical layer can be integrated into an FPGA for extremely small and cost effective camera implementations. Dual-IB-cable implementations extend the data bandwidth to 600 Mbytes/second. Higher bandwidth implementations can use CX4 thumbscrew cables or Infiniband 12x cables.

Open Standard Intended

Dalsa intends HSLink to be open to the entire machine vision industry. Efforts are underway to turn HSLink into an open industry standard; meanwhile several companies have joined Dalsa in supporting HSLink in their new designs. None of the technology that Dalsa has developed for the interface, including the HSLink IP core, requires license or royalty fees and the PHY devices are widely available. HSLink is thus well positioned to be the next-generation interface for machine vision systems.

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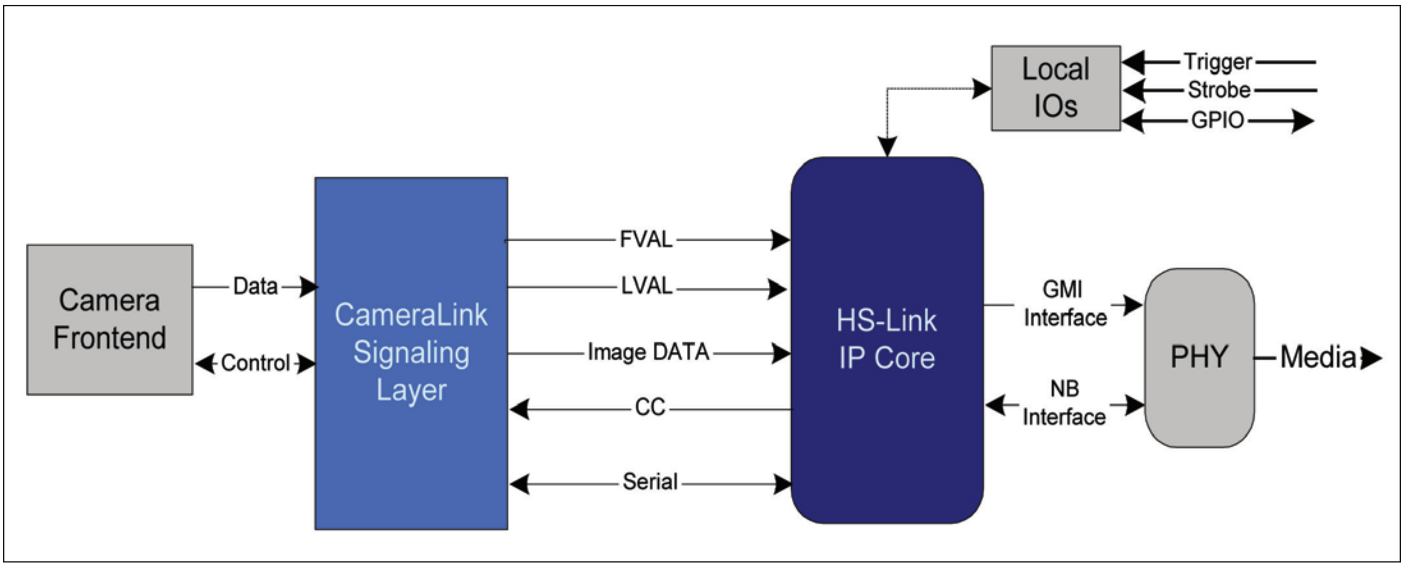

Fig. 1: The HSLink interface takes Camera Link signaling and creates a single, unified channel carrying control, trigger, I/O and video data between camera and frame grabber

Perfect Start on the Fast Track

Tubular Frame Profile Detection for Plastic Windows

The Independent Vision System In-Sight

The success of the In-Sight product family is based on the user-friendly hardware and software structures of the independently operating vision systems. The complete system including camera, computer, communication interfaces and individual LED lighting is integrated with high density into a small, robust plastic housing with IP67 protection class or a stainless steel housing with IP68 protection class. The very compact design ensures simple local installation in the process lines.

The vision systems of the In-Sight product line with the 5100, 5400 and 5600 series and the small In-Sight Micro 1020 to 1413 series take over tasks which were previously reserved for PC-based systems. They have therefore become an important part of quality assurance, identification and process optimization in all branches of industry.

The new Cognex Connect communication package enables simplified connection of the In-Sight vision system to the PLCs, robots, MMS and field bus systems normally used in factory automation. The vision software package with PatMax, PatInspect, PatFlex, IDMax and OCVMax and its reliable algorithms and vision tools is available for In-Sight.

Cognex has laid a further milestone in the development and production of vision systems with the In-Sight Micro product line. In the minimum dimensions of just 30 x 30 x 60 mm, a powerful, independent working image processing system was integrated. This product family covers the range from standard resolution to 2 megapixels image resolution in color.

The aspect of an easy to use vision development environment is important for the user and system integrator. Whole networks of vision systems can be created and programmed with the In-Sight Explorer and the new VisionView 700 control unit. With the new EasyBuilder configuration software, the high-performance machine vision tools can also be used without the corresponding programming skills, an important basis for designing an effective process optimization.

To be successful as an international player, a family business needs to ensure two things: top quality and high productivity, like the company Arndt Fenstertechnik with its new cutting center for plastic windows. To achieve both goals, the small and powerful In-Sight vision system from Cognex plays an important role.

Tighter insulation regulations and rising energy prices are fanning the demand for plastic windows. Very good insulating properties for both heat and noise combined with low maintenance costs are arguments in favor of this modern material. Even in terms of esthetics, plastic windows have now overtaken wood and aluminum in popularity with buyers because of their wide variety of colors and designs. Customers may like it, but this variety presents a challenge to the people responsible for production. Growing variety and rising demand require production lines to be more and more flexible with higher and higher throughputs.

A Hurdle Just Before the Finish Line

Just before completing the planning phase of the new cutting center, Arndt Fenstertechnik faced the critical question how they could achieve a high speed in the material feed area whilst simultaneously achieving a zero fault rate. In-

The In-Sight Micro 1100 from Cognex checks whether the rectangular tubular window frame put on by hand matches the IT system specification

The operator can always see the current production process with the graphical user interface VisionView

correctly-fed frame parts could have led to damage to the line, resulting in costly down-time. 40 different tubular window profiles need to be identified in seconds in the three basic colors of gray, brown and a mixed shade for recycled products.

The company was looking for a reliable, low-cost solution to optimize the most important process steps in the new cutting center. After intensive research, they selected Cognex, specialists in intelligent vision systems. The In-Sight Micro 1100 was planned and installed in collaboration with Peter Scholz Software+Engineering GmbH. The company based in Weiden, Germany, has been developing vision systems and industrial software solutions since 1997, and has extensive experience in the field of optical profile detection.

Set-actual Comparison of Frame Profiles

Before the intelligent vision system focuses on the profiles from the side, one of two operators places the rectangular plastic tube, which can be up to 6 m long, on the conveyor. The central IT unit indicates which profile is to be put on. Equipped with the individual product information, the Cognex vision system checks that the profile cross-section matches the data required by the system. The window frame profiles differ in terms of both external contour and the chambers inside. Many profiles vary only in terms of their dimensions.

Assisted by special infrared LED spotlights, the In-Sight Micro 1100 is able to detect ten definable features at this point. Different exposure times ensure reliable product detection, even if the colors of the material change. Equipped with a VisionView graphical user interface, the operator can always see the current production process. The intelligent vision system, measuring just 30 x 30 x 60 mm, thus guarantees up to 100 profile switches a day, maintaining a reliable process.

Extensible System

The In-Sight Micro 1100 works completely independently. A notebook is required only to teach new profiles. Arndt Fenstertechnik aims to link the vision system to the company's central IT system shortly to enable authorized employees to access the vision system from any PC within the system.

It was important to Arndt Fenstertechnik to put the maintenance and installation of new profile data in the hands of its own employees. As the extensive product portfolio of window profiles is continuously expanding, the aim was to minimize the cost factor of frequent reprogramming. One of the strengths of the In-Sight Micro 1100 from Cognex picked up extra points with its EasyBuilder configuration software. Its vision tools allow new profile detection patterns to be compiled at a stroke. The intuitive, user-friendly interface leads a user through the whole of the set-up process step by step until the application solution is complete. Once configured, the In-Sight Micro 1100 ensures short cycle times and correct parts feed without any PC input at all.

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New Dimensions in Inline Surface Inspection

3D Technologies and Artificial Intelligence Open up New Potential

Professional optical surface inspection remains a great challenge for machine vision. Flexibility due to reusable modules, fast 3D technology and artificial intelligence methods offer new starting points to handle fields of application that were, until now, inaccessible.

Surface inspection, especially in the field of industrial quality assurance and process control applications, deals with the detection and analysis of structures and surface defects in a variety of objects. Defects on functional surfaces cause quality problems in automatic production processes. But even when esthetic standards are addressed, surfaces are not only inspected skin-deep. Due to the vast variety of possible structures and defects, surface inspection is quite often still done by visual inspection, which is costly and prone to mistakes. In many cases automated optical surface inspection remains a technically demanding goal, all the more so when geometric measurements and pattern recognition are required at the same time.

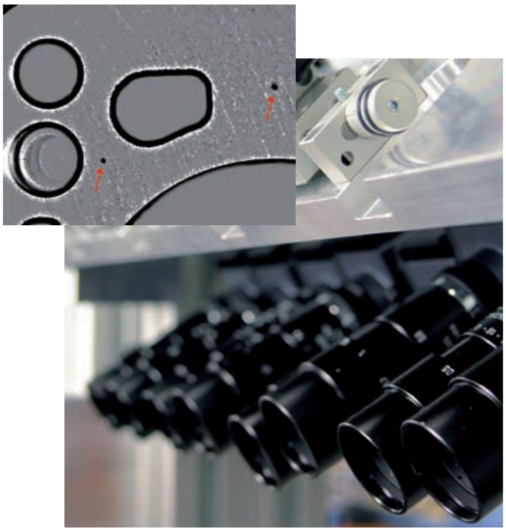

Fig. 1: Inspection of a cast-aluminum component sealing surface: With the help of a special illumination technique the two deficiencies marked by the arrows are clearly visible.

A Question of Speed

If 100%-control is required, surface inspection has to be performed in real time. Inline inspection systems are expected to work synchronously with an external clock. Speeds may range from several parts per minute for discrete objects to several meters per second in strip-material production. Multi-core computers and parallel processing, distributed processing power with smart cameras, and intelligent sensors provide a thrust of innovation. Especially for multi-sensor applications, GigE cameras with Ethernet interfaces are more and more often employed. Since most users are familiar with Ethernet from computer networks, GigE cameras are widely accepted without resentments. However, a drawback in many real-time applications is the lack of a genuine determinism. Therefore, inexpensive standard cameras with versatile and simple trigger functions are still an option.

To master ambitious tasks demands a lot more though: refined and optimized algorithms, reusable, specialized and yet flexible software libraries, robust integration of many different sensors and the perfect interaction with a variety of handling and control systems. Ideally, programming should be replaced in a wider sense by merely reconfiguring tasks and modules. Figure 1 exemplarily shows an inspection system for cast-aluminum components, which was designed using

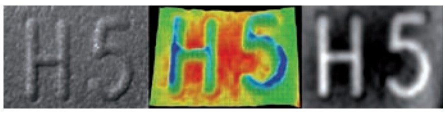

Fig. 2: Left: 2D image of embossed structures in cast iron. With standard methods robust character recognition is not possible.
Middle: Color-coded 3D image.
Right: The gray-scale coded 3D image allows a stable analysis using standard OCR software.

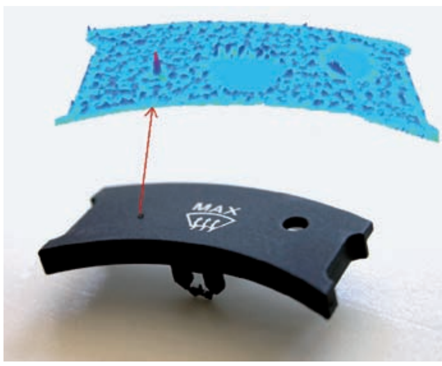

Fig. 3: Paint flaws on an operating button are clearly detected.

the InspectPro tool box. In this project, code readers, laser-scanners for position measurement and a multi-camera system with structured illumination for the surface inspection have to interact quickly and smoothly with the mechanical handler and the main computer.

Brought to Light

It's almost a platitude, but nonetheless important: Good visibility of all details to be analyzed is the main precondition for any automatic image processing project. This must also be guaranteed at varying ambient light conditions and deviations of part positions and shapes. Unfortunately, due to the infinity of possible tasks there is no ideal illumination and no perfect sensor especially suited for surface inspection. The palette of possible surfaces covers a broad range: shining, dull, smooth, coarse, colored, deep black, transparent or even self-luminous. In accordance, the light source may be directed, telecentric, coherent, structured, white, monochrome, IR, UV, continuous or flashed. Variations and combinations are virtually infinite. For these reasons, the selection and optimization of light sources and matching sensors which are best suited for a given project require a lot of experience, engineering competence and good market knowledge.

The Third Dimension – Also for Surfaces

It sounds like a contradiction at first glance: Even though surfaces are assumed to be "flat", 3D imaging may be used as a supplementary technique in surface inspection. Whenever problems with contrast, reflections and surface texture obviate the capture of sufficiently good images with conventional methods, 3D image recording may deliver significantly better raw data allowing subsequent processing with now again conventional 2D inspection algorithms. Important is a depth resolution in the range of micrometers with a comparatively large lateral field of view, robustness for ambient light, high processing speed with several image acquisitions per second, and an acceptable price tag. At present, the shape-from-shading technique [1] in the real-time-version Sparc, which scooped the Vision Award 2007, seems to be the trendsetter.

The example of cast-metal embossments highlights the advantages of 3D preprocessing. Even sophisticated illumination techniques would not guarantee an image quality sufficient for robust code identification in this case. 3D image caption, on the other hand, delivers gray coded height profiles with good and stable contrast values (fig. 2). Subsequently applied algorithms for optical character recognition and symbol verification now work reliably even at strong fluctuations of surface texture, sample positions, and reflection conditions.

This new approach is by no means restricted to OCR and OCV tasks. The combination of 3D technology and surface inspection stood up to the test in the recognition of scratches, fissures, sink holes, cavities, inclusions, grains, elevated textures and patterns, impressions, varnish runs, orange peel, roughness and more. As an example figure 3 shows paint flaws on an operating button, which are clearly visible in the 3D image. At the same time characters and symbols can be inspected. Further applications are the determination of grooves and roughness parameters on finished surfaces like wood, leather, fabrics and plastic materials (fig. 4).

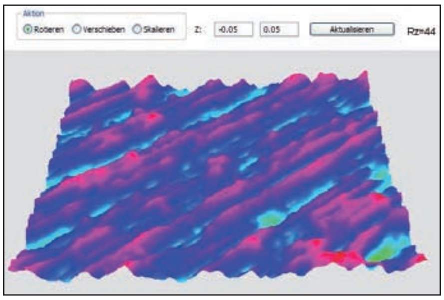

Fig. 4: Roughness and principal orientation of a machined wood surface can be determined easily with shape-from-shading methods.

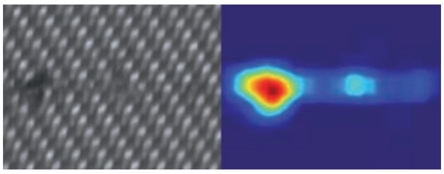

Fig. 5: Left: 2D image of a fabric with a weaving flaw. Right: Defect localized with Context after 3D preprocessing.

Artificial Intelligence for Complex Tasks

Some subtle surface flaws cannot be classified by either geometrical or statistical approaches. Examples are stochastic textures, complex organic structures like wood grain and diffuse surface defects which are not reproducible. Some techniques for pattern recognition borrowed from the area of artificial intelligence (AI) turn out to be very helpful in these cases. Worth mentioning are multi-scale filters, fuzzy logic, neural networks and support vector machines. A common feature of these systems is that they must be trained by numerous examples.

Appropriate AI tools are Manto [2] and the new technique Context [3]. The latter can distinguish between two classes after a learning phase using only good samples. In combination with 3D preprocessing, Context proves to have a high sensitivity to clandestine texture imperfections like weaving flaws (fig. 5), which would hardly be discernable in a 2D approach.

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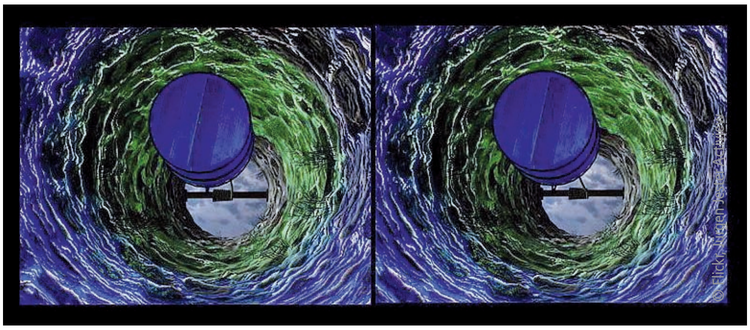
Line by Line Stereo

Metrological 3D-Stereo with Line Scan Cameras

Determining the shape or spatial position of a work piece in 3D is increasingly important in quality control, robotics und type identification of products. At the same time metrological tasks are no longer carried in a mere sample check, but 100% control is requested with integrated inline inspection systems. Scanning stereo systems based on line scan cameras are well suited for the task.



Apart from some highly specialized and rather complex non-optical technologies like computer tomography and ultrasonic measurements, mainly optical methods are used today for 3D metrology. The most frequently used optical inline measuring principles today are laser scanning and (mostly phase-shifting) projected fringes techniques. In practice, however, there are several constraints for these technologies often not adressed initially. Thus the measuring distances to the examinated objects are too much restricted and the viewing angles have to be well-controlled. Therefore the necessary handling and positioning systems for the sensor systems may become very complex. If the angles between the incident light rays and the surface normals exceed certain thresholds the measurement errors are rapidly increasing. Moreover, the reflectance properties of the surfaces under inspection substantially influence the measurement accuracy. In any case, the outcome of these techniques is a point cloud of sampled surface points. Thus, the final task of fitting the intended CAD-geometry into the scattered measurement data in order to get resulting form deviations has yet to be done.

Stereo Scanning Mode

Genuine stereo reconstruction, which is extensively treated in scientific literature, is seldomly encountered in industrial applications. The method seems to be not applicable for scanning mode. For broader viewing angles or larger parts the same restrictions are assumed as with the classical methods. In addition, for practical use multi-camera systems would be needed in multi-stereo operation.

The scene changes when taking line scanning cameras into account: not just two, but an extendable number arranged in a line, according to the application demands, with every adjacent pair of cameras forming a partial stereo pair. Today, scanning systems of this type have been developed and tested in applications with high flexibility demands concerning measuring distances, surface properties and new strategies of model-based stereo techniques to overcome the lack or inaccuracy of significant points, edges and frontier curves of visibility. Moreover, these systems allow for free integration of light projection methods whenever necessary, without a complete system redesign.

The illumination can be well-controlled on the scan line, thus nasty reflectance properties are often easier to handle than with laser scanning systems. Non-standard reflectance problems on technical surfaces can be compensated with quick changes of illumination directions (interlaced between lines).

According to the application either the line scan stereo bridge is moved linearly over the object to be inspected, or the stereo scanner remains stationary while the object is moved. The metrological 3D surface data are generated line by line in full cross-sections of the part, thus supporting a direct comparison with the CAD-data.

Manifold Application Areas

3D line scanning stereo systems are easily extendable up to almost arbitrarily big scan line cross sections. However, there are several challenges when designing these systems. Thus, for instance, the calibration techniques for line scan stereo with high accuracy are rather sophisticated. In addition, one of the main tasks is the design and implementation of real time constraint- and model-based reconstruction algorithms suitable for metrological line scan stereo. On the other hand, integration into a production line is often convenient in practice.

Typical fields of application for 3D inspection based on line scan cameras are cutting or sawing processes in big tranches, quick type identifications based on object shape or position detection for subsequent handling. If metrological tasks have to be solved in combination with the detection of surface defects, the technology is optimally suited.

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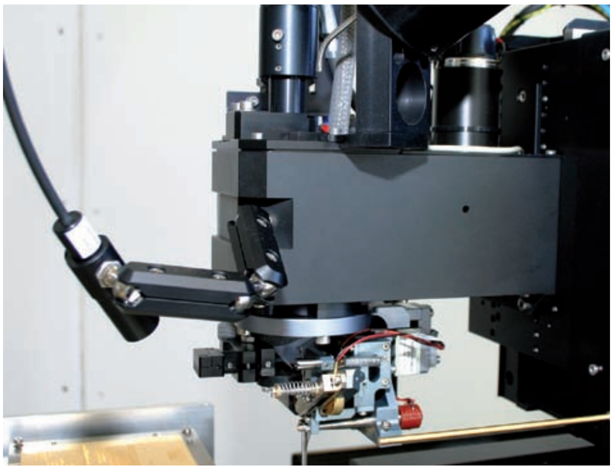
Flexible Positioning and Strong Hold

Knuckle Joint – Not Only – for Precision Positioning of Light Sources

Many traditional fixations do not allow flexible illumination positioning combined with an ability to firmly lock components into their optimum position. This is most apparent in manufacturing assembly machines where constant vibrations and small spaces make it inherently difficult to maintain the exact positioning of illumination and other components such as cameras over sample areas.



A robust yet simple, flexible, and cost effective solution in form of a secure, lockable flexible joint is now offered by Opto, a German manufacturer and integrator of opto-mechanical components and systems: The Jointed Coupler, or 'Knuckle Joint.'

Opto's Jointed Couplers can be positioned into any position and orientation with zero hysteresis and with secure fixation achieved with a simple Allen wrench. Zero hysteresis with smooth positioning is achieved through a combination of the low friction surfaces of the nickel plated pin joints in an anodized alloy casing. Jointed Couplers can be linked together to make any chain length and offer direct fixations to M6 and M8 threads in addition to a 1/4" camera mount thread. For medical or custom applications nickel plated and special versions are also available.

Typical applications for the Jointed Couplers are diverse – they are used by the semiconductor industry in bonding machines, where they enable optimal and long lasting orientation of the illumination field onto fragile gold connections during processing. In the field of microscopy, fiber light guides are now held securely in position, enabling effective dark field illumination of samples, with no gradual sagging of the fiber cables. With Opto's Jointed Couplers, sensitive tools, sensors or any other accessories can now be securely positioned and fixed in rough environments. In the areas of R&D Jointed Couplers are found in numerous applications in test and lab set-ups. The extensive range of optional accessories and attachments as well as the robust design of the Jointed Couplers downright provoke new applications.

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Unique Requirements Attractively Met

Micro Video Lenses Increase Machine Vision Applications Range

At one time micro video lenses for compact machine vision systems supported only low resolution applications. Reductions in the size and cost of optical sensors along with increases in pixel count now allow high resolution in compact systems. New optical designs are yielding micro video lenses with increased resolution to match today's sensors, increasing their applications range.

The digitalization of machine vision has resulted in increased resolution and lower cost for sensors, but the optics typically remained basically the same. Most video lenses for machine vision use a C-mount and are designed for a sensor size of 2/3˝ covering an image circle of 11 mm. Now, however, high resolution CCD and CMOS sensors are available in sizes around 1/3˝, creating a need for optical manufacturers, such as Edmund Optics, to reduce lens size and price accordingly.

These micro video lenses are approximately 15–25 mm long with an outer diameter of 14–18 mm. The mount is usually an S-mount (M12x0.5-thread). This compact size provides an advantage over traditional C-Mount lens and camera systems not only in terms of smaller assembly dimensions but also reduced costs.

The cost reductions do not come primarily from the lens, however. To maintain high quality the lenses are made of glass and metal only; no plastics. Glass costs do reduce slightly with smaller lens diameters, but other cost reductions come from the mechanical design. For instance, micro video lenses can avoid use of an expensive helical focusing mechanism and use the mounting thread to adjust position. Another cost reduction design step is to control aperture by using a spacer of the proper diameter between the lens elements instead of iris leaves.

For screw sorting the Leuze LSIS 412 vision sensor can be easily used. (Courtesy of Leuze electronic)

Two micro video lenses track the bullet in the shot-scoring system OpticScore.
(Courtesy of Knestel Elektronik)

Micro Video Lens Selection

A wide variety of micro video lens designs are now available from stock to meet different requirements. Basic infinite conjugate imaging lenses, for instance, are suitable for standard resolution cameras with a working distance of dozens of centimetres. Such lenses are available to cover a wide range of focal lengths from 1.7 mm to 50 mm, enabling angular horizontal fields of view between 6.8° and 134°. There are also high resolution versions available with a recommended working distance of 40 cm or more.

For vision applications that require close-in operation, finite conjugate imag-

A micro video lens keeps the optical document reader in this Desko MPR 7100 e-Passport reader small, lightweight and cost effective. (Courtesy of Desko)

ing lenses provide recommended working distances of 15–25 cm with focal lengths between 5 mm and 25 mm. Typically even shorter working distances can be achieved. Resolution performance can be as high as 200 lp/mm.

When choosing a micro video lens look first at the sensor size and resolution. For sensors with more than 1M-pixels a high resolution lens is best. The next parameter to consider is the (angular) field of view, which is easily calculated from working distance, sensor size, and object size.

If there are no standard lenses available for a given application, the optical manufacturer may be able to help with a modification of a standard product or with a custom design. Manufacturers can modify lenses to include filters to reduce camera cost or to change apertures to increase the depth of field. Increasing the depth of field can allow an otherwise standard lens to operate at a closer-than-specified working distance and is also helpful in applications where an object's z-position might change. Barrel changes are another modification option when standard housings do not fit a given camera.

A typical custom design will consist of three to six lens elements and will depend on the target price and optical performance requirements in terms of modulation transfer function, distortion, relative illumination, and other such factors. Customers also need to specify mechanical constraints such as mounting style, sensor size, and working distance. The manufacturer's optical designers are often able to make helpful design suggestions to optimize cost and performance. Manufacturing can start with just 50–100 pieces.

Applications Abound

Micro video lenses serve best in applications where the classical camera/objective lens combination is too expensive and too bulky. Often these are new applications that use a micro video lens together with a more-or-less specialized vision sensor. In more and more cases the sensor has the lens built in, as with the Leuze LSIS 412 vision sensor. The result is an imaging system that can be integrated almost anywhere.

With a wide angle (>90° horizontal) micro video lens, for example, it is possible to place a vision sensor in one corner of a rectangular space and monitor if something passes through that space. This can be used to replace safety light curtains in workshops, with the system shutting down the machinery if the danger zone is entered.

The OpticScore electronic shot evaluation system from Knestel Elekronik GmbH uses two high-speed sensors with micro video lenses to capture images of a bullet in flight. Working at 40,000 frames per second, the system captures multiple images of the bullet as it passes through the light curtain. This system offers users more reliable and accurate measurements compared to existing scoring systems.

Other applications for micro video lenses can be found in fruit detecting scales in supermarkets, automated contour measurement in manufacturing, lottery scanners, and passport readers at customs stations. The MPR 7100 e-Passport reader from Desko GmbH, for instance, uses a custom micro video lens as part of a multi document reader for security and passenger service stations at airports. The optical reader module is no larger than a matchbox.

Micro video lenses thus allow compact imaging solutions for large quantity production at a favorable price. This is making imaging systems more affordable and easier to use within severe spatial restrictions. And with the help of the lens manufacturers, even unique system requirements can be met without compromising cost or performance.

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Camera Control by Using Just One Cable

For automated industrial inspection machines and vision systems, Baumer has introduced the GigE Vision Trigger device designed to control single-camera or multi-

camera setups, eliminating the need for hardware triggers and greatly simplifying cable requirements. Featuring multiple input/output ports, these devices can eliminate the need for PLC controllers by combining sensor information with machine vision applications. With eight inputs and eight outputs, the GigE Trigger device provides many connections for integrating light barriers, encoders, sensors and actuators and eliminates the need for a digital I/O card located in a PC. The device itself evaluates input signals and provides real-time control of additional process steps. In combination with a switch the GigE Trigger device can be used to control multiple cameras, and supports all Baumer standard GigE cameras or PoE cameras.

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Multi-spectral Camera Now with GigE

JAI announces the release of the AD-080GE with GigE Vision interface. The AD-080GE is an innovative 2-CCD camera capable of simultaneously imaging visible and near-infrared light spectrums through a single lens. The camera features two 1/3" progressive scan sensors (1,024 x 768 resolutions) mounted to a custom-designed optical prism and it runs at a frame rate of 30 frames/second in continuous operation. The technology behind the AD-080GE is a unique manufacturing process developed by JAI, enabling high-precision bonding of image sensors onto the customized prism optics. The camera is designed for a variety of applications, like the fruit and vegetable inspection. There, the visible spectrum inspects surface colorization while the NIR channel inspects below the surface of the object revealing possible imperfections, such as bruising or decay.

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Industrial Cameras with New HDR Sensor

The camera manufacturer IDS announces the release of a newly developed HDR sensor for their USB and GigE industrial camera series. This technology allows capturing images with ultra-high contrast and a dynamic range of over 120 dB, which is about 1,000 times more than conventional CCD sensors can provide. The HDR cameras

thus open up many new possibilities for applications that have very high brightness differences, such as traffic surveillance or industrial welding. Significantly, the monochrome HDR sensor reduces visible noise compared to previous HDR technologies. As a result, GigE cameras of the uEye HE series can read out and process the full 12-bit color depth. The FX4 HDR sensor is 1/1.8" in size and captures up to 50 frames per second at a resolution of 768 x 576 pixels.

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Lens Manufacturer Enters LED Market

Schneider Kreuznach is expanding its expertise in the area of optics to include LED illumination. The company is looking to design and produce customized solutions combining new levels of precision and brightness for demanding tasks. Currently, solutions for applications in the area of machine vision, medical technology and semiconductor technology are in the pipeline. "We have already received several inquiries and are planning to offer LED illumination systems that fully capture the potential of our precision photographic lenses," said Dr. Josef Staub, CEO of the Schneider Group. The company's product designers are exploring new ways of overcoming mechanical and thermal hurdles. The aim is to increase the level of efficiency so that a higher performance can be achieved with fewer LEDs. The first products are expected to come onto the market in the course of the year.

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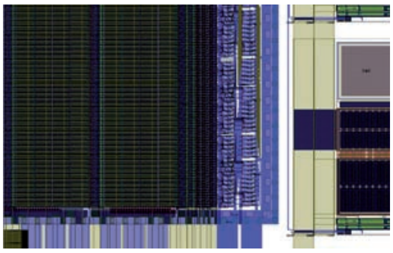
Embedded Low Power A/D Converter



New Imaging Technologies (NIT) announces the release of a novel low power A/D converter for CMOS high dynamic range true logarithmic imaging sensors. This ADC IP uses a flash design resolving the historical high power, high input capacitance and high noise level problems in such architecture. The low switching noise is one of the most important key characteristics for on-chip integration on a logarithmic sensor where the signal level is much lower than that in a conventional sensor. The A/D converter is available at 8 bits or 10 bits resolutions, which will be incorporated in the next generation megapixel snapshot color Magic sensor series. The application fields of NIT's optical and imaging sensors are in the industry and research, as well as in medical and defense organizations around the globe.

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Driver Package for Any Kind of Vision Application

Basler Vision Technologies has released version 2.2 of its pylon camera driver package. The package can be downloaded for free from Basler's website. This pylon release offers two main enhancements: It includes support for several additional programming languages, such as Visual Basic 6.0, C, and Microsoft .NET, and it allows comfortable Camera Link camera configuration via a GenICam compliant API. In addition, Microsoft's newer C# and VB.NET programming technologies are now supported by pylon 2.2. All of the new APIs (application programming interfaces) have full access to all of the camera and grabbing features on Basler's IEEE1394 and GigE Vision camera. Each new programming language extension comes with its own comprehensive documentation and a set of code samples that demonstrate the main application tasks and can be easily expanded to cover new customer applications.

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Imaging Software for the 32 Bit Version of Windows 7

The Version 10.2 of the Common Vision Blox (CVB) programming library supports all 32 Bit versions of Microsoft Windows 7 and includes the AIA certified CVB GenICam driver that is compatible with the latest GenICam V2.0 Standard. Moreover, the new version includes new tools for specific vision applications and tasks. The toolkit now includes CVB Movie 2 for sequence recording - the successor to the CVB Movie tool. CVB Movie 2 allows additional text meta data such as time stamps to be recorded into the AVI container. CVB 10.2 also incorporates a powerful calibration algorithm for 3D point clouds: the CVB Metric 3D. This update is free of charge for registered users of Common Vision Blox. A free 14-day trial version for all components is also available for feasibility and performance tests.

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Distortion-free Optics for Line Scan Applications

Moritex has developed a new lens for high definition line scan cameras: the ML-L00502. It offers an exact, high-contrast picture display at a screen diagonal of up to 62 mm, today's maximum applicable CCD sensor length. The illumination drop between the center and the periphery of the field of view is less than 20%. The distortion of the optic is less than 0.1%. With these data, the latest generation of CCD sensors with a resolution of 12,000 pixels can be capitalized. This also makes them attractive for high-resolution Matrix sensors. Machine vision systems that are based on line scan cameras are increasingly being used for quality inspection as well as sorting procedures, like for quality assurance of solar modules or printed circuit boards for computers.

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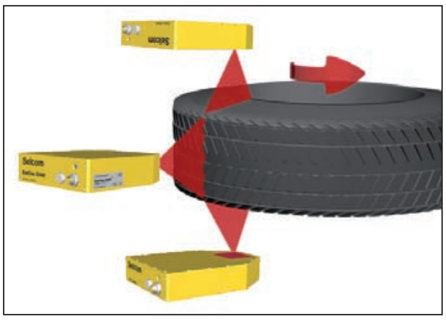
High-speed, High-tech, Profiling

Laser Sensor Innovations Improve Tyre Manufacturing

Tyre and rubber manufacturers are requiring inspection systems to detect small geometric defects wherever they occur on the rubber surface in both final and in-process inspection operations. To increase quality and improve product safety, these smaller areas of dimensional variation or defects must be detected with very high reliability.

To meet these expanding requirements, sensor manufacturers have developed new and very high speed laser line sensors, such as LMI Technologies' Selcom EyeCon product line, to acquire high density data to insure detection of the smallest defects. These high-speed laser line sensors generate masses of data, requiring a reliable communications network easily implemented by machine builders, without the cost and risk of developing custom communications links. Simplicity of implementation benefits end users with high reliability, low cost and minimum maintenance.

In tyre manufacturing, multiple sensors are often implemented in a single station to cover the full surface of the product with high resolution. This adds further complexity requiring tight synchronization of data from all sensors and encoders. The issue has been resolved by development of a unique platform, providing microsecond synchronization between sensors, and assembling data from all sensors into a single 3D profile map, output to the host over a single Gigabit Ethernet cable.

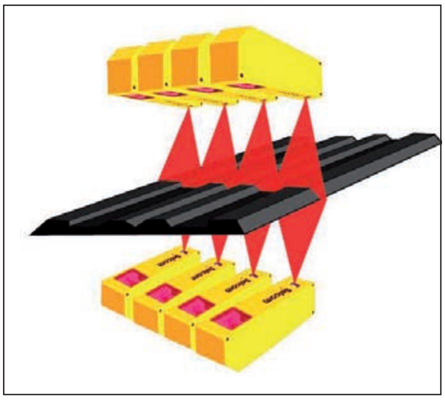


In a typical tyre final inspection system one laser line sensor is inspecting each sidewall and a third one is inspecting the tread

Communication via GigE

A typical inspection application may use multiple laser sensors inspecting different zones of the product, such as calendered rubber, conveyor belts or tread extrusions. An in-process profiling application may use eight or more sensors (half of them above and the other half below the conveyor) to provide high data density across the full width of the extrusion.

The massive amount of data generated in these applications must be sent to the inspection station's host computer for analyses. For convenient layout of inspection stations, and to simplify the task of the system integrator, it is desirable for the host computer to be remotely located, often at a significant distance from the sensors. Gigabit Ethernet (GigE), broadly used and easy to apply and implement, provides the optimal communications standard. It provides data rates up to 1,000 Mbps, with inexpensive cables running up to 100 m without repeaters.



Eight sensors are used for the in-process profiling application to provide high data density across the full width of the extrusion

Total Integration Architecture

Implementing multiple laser line sensors to cover the full surface of the object creates challenges of synchronizing data from all sensors, and stitching multi-sensor data streams into a single file, without requiring the integrator to carry out these complex operations in the host computer. Synchronization insures that data from each sensor is obtained at essentially the same point in time. Otherwise, each sensors data will come from a different position along the length of the surface. Stitching involves combining the synchronized profiles from each sensor into a single 3D surface map, transmitted as a single data file to the host.

To simplify the tasks of synchronization and stitching for the system integrator, LMI has developed the FireSync platform. This platform is designed to accept and integrate data from multiple vision sensors, as well as other local inputs such as encoders and photocells.

This approach simplifies data analyses in the host computer, because profiles output by all sensors are tightly synchronized within the sensor system itself. Each “slice” of data from all sensors is combined into a single complete 3D data file, sent from the platform over a single GigE output cable to the host computer. This total integration architecture simplifies installation.

The platform also provides tools for multi-sensor position calibration using an appropriate artifact of known dimensions that is placed in the system measuring area. This process locates each sensors position with respect to a global coordinate system defined relative to the target. Transformation parameters for each sensor in the system are acquired during the system calibration process and are used to transform profile data from the multiple sensors into a single coordinate system.

Tyre Final Inspection

Typical tyre final inspection systems use three high-speed laser line sensors, one inspecting each sidewall and the third inspecting the tread. Each sensor measures hundreds of points along the laser line, at frame rates of 4 kHz or faster. The FireSync platform provides synchronization and stitching functions for the three sensors. The application is complicated further by the need for analyses software to remove or filter out all points that relate to raised lettering, bar codes and other acceptable variations in the surface. The sensors employ “dual triangulation” with two cameras viewing the laser line, one on either side of the laser projector. This design eliminates data dropouts caused by shadowing of the laser beam at the edges of raised material on the sidewall surface.

Simplified Integration – Maximized Reliability

Today’s high-speed laser line sensors provide high-density data to detect and quantify defects and dimensional variations in both in-process and final inspection applications in high volume tyre manufacturing. Synchronization and communications issues are simplified by the FireSync platform, with communications to the host computer on a single Gigabit Ethernet cable. The platform is designed to simplify the tasks of system integration, and maximizes reliability for the end user.

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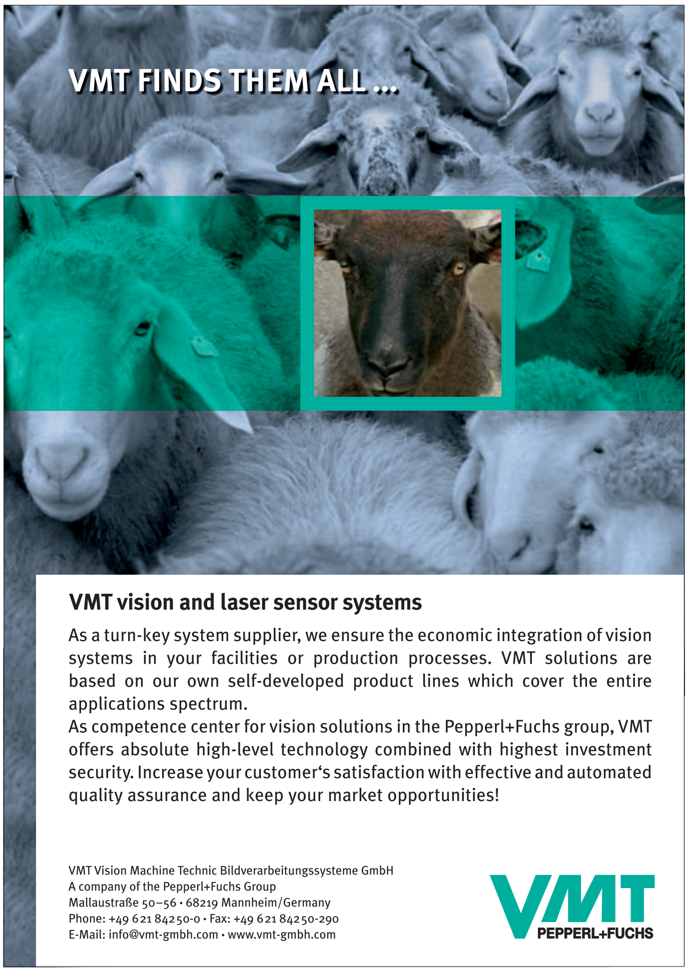
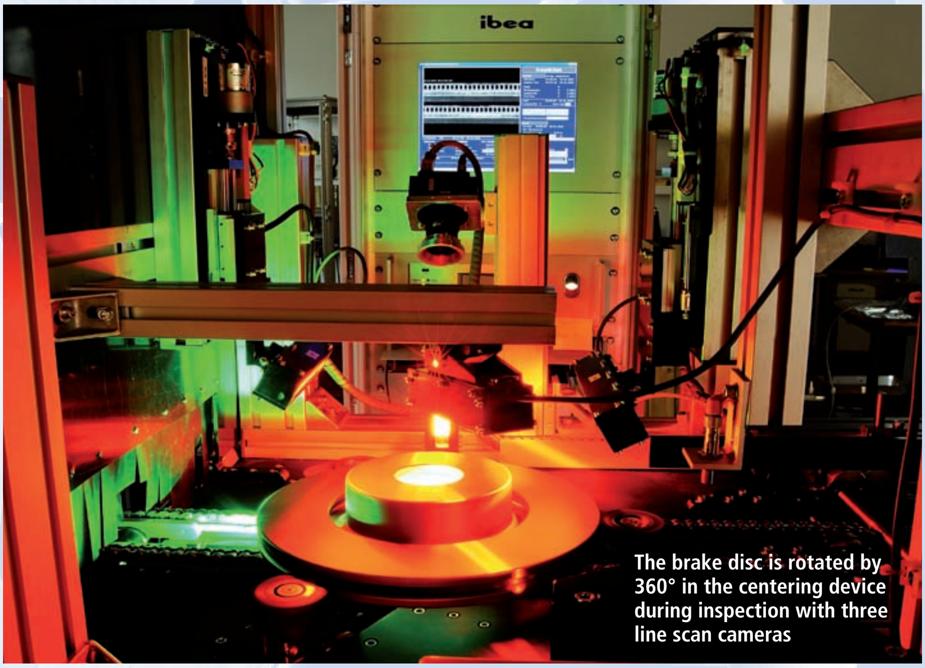


We exhibit at: AUTOMATICA · Hall A2 · Booth 310

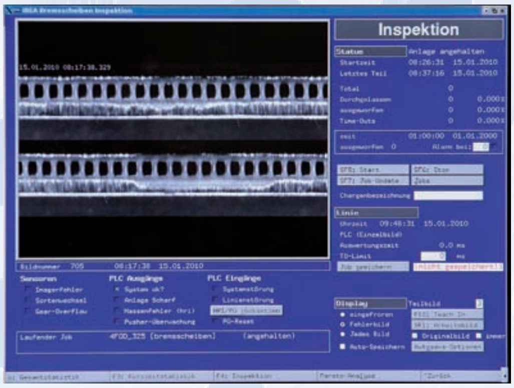
Everything under Control?

Self-sufficient Inspection System for Brake Disc Control

Whether Harley or Soccer Mom Wagon – only flawlessly working brakes guarantee the safety of passenger and vehicle. That's why the automotive manufacturer relies on brake discs with a documented and reproducible series-production quality. The quality control does not confine itself on final control only: Already the raw brake discs are inspected for non-conformities with a system integrating both inspection and handling.



The brake disc is rotated by 360° in the centering device during inspection with three line scan cameras



Detection of cleaning defaults on the side wall of the cooling channel

The inspection of raw brake discs before continuing with further processes turns out to be profitable. In this production step already non-conformities can occur which can be detected and which prohibit the future usage and therewith the sale of the brake discs. However, up to now this inspection has been done mostly manually. Due to frequently alternating people doing the same inspection, the resulting rating can be no more than a subjective one. This can lead to insufficient inspection and thus to consequential costs up to sales returns and reputation damage. The company ibea located in Hamburg, Germany, has developed an automated system which integrates the inspection and handling of brake discs. One of the main goals has been to replace the manual inspection and to integrate existing machinery, so that a collective overview journal of the brake disc can be generated.

Defect Separation with Dark Field

The raw brake discs are cast parts. 90% of the defects are caused during the casting process, e.g. blowholes, pores, blister, cast appendix and filled ventilation channels. The other 10% are e.g. surface or core defects. A lot of the defects exhibit indentations and therefore usually imply the application of triangular lasers. Since the inspection should do both surface inspection as well as structure analysis, the machine vision system by ibea is equipped with dark field illumination instead, which enables the system to recognize the cavity and to deal with contrast defects separately.

System Design

The self-sufficient inspection system primarily consists of a simple centering device for the well-defined rotation of the brake discs. During the rotation three Dalsa line scan cameras with Camera-Link interfaces take images of the upper side, lower side and the cooling channel side. By means of this simple handling a fast processing with different dimensions is possible. Furthermore, the wear of parts is reduced to a minimum. Expensive handling robots are not necessary and the accuracy of the image acquisition can also be used for measurement purposes.

The raw brake disc is usually delivered on a roller conveyor. The inspection system is designed for different diameters (max. 50 cm) and heights (max. 15 cm). The parameters are set and saved job wise and can be started up according to selection. The job data includes the data for comparison with reference values for the vision inspection as well as the data for references of mechanical adjustments for e.g. illumination devices or pre-positions of handling devices. By means of a front end entry pulsing device the discs are run in to the test cell separately. The transport takes place on non-wearing chains, firstly on a separating conveyor followed up by the transfer to the test conveyor belt, which then moves the disc to the centering device. All conveying processes are done by a high-performance servomotor.

From Three Sides

The disc is positioned centrically above the centering device. There the disc is pre-centered and is then picked up for the exact centering. As soon as this has been achieved the disc rotates 360° and images are taken with three line scan cameras. One camera takes an image angular from beneath and one camera takes an image angular from above. The third camera takes an image of the cooling channel. During image acquisition a special laser illumination provides for a sufficient illumination of the parts.

The images taken from above and below are arranged in such a way that all defects can be found with merely one image acquisition and a fixed illumination. This applies especially for casting faults such as cavities and bubbles.

Multitude of Inspection Criteria

Following criteria are tested for on the raw brake disc: Diameter and height, imprint or symbols, blowholes, flash, filled ventilation channels, half fans, bubbles in the fan, cracks, and deformations. Contaminations – even if they look like defects – must not be rejected. Therefore the system makes use of the dark field illumination to distinguish between area defects and cavities. The generally used laser-triangulation procedure is not applied by ibea by choice.

The system works almost wear-free at approximately six discs per minute. It consists of an image processing module and a drive module, which is accommodated in a system control cabinet. The operations and also the motor adjustments are controlled by a program. The system is user friendly and already prepared for the interlinking with existing lines. For the separation of good and faulty parts diverters and ejectors are offered. The transfer to a pack-robot is already prepared.

Compact and Economical

The main body of the system is designed as a welded construction. Mounted on this construction are all the motor drive elements. To disconnect the agitation all optical elements such as camera and illumination have been mounted onto shock absorbers. The system consists of infeed and outlet conveyors (rolling bar) for instant integration into existing lines. Respective trigger sensors and counters are already integrated. The system comes in a lightproof cabinet with high pressure connection to take in filtered air and to keep the dust away from the inside. The system requires 6 bar compressed air inlet and a wide range AC input of 110 – 300 V.

The cost performance ratio is very attractive: the investment will be amortized within 1.5 years.

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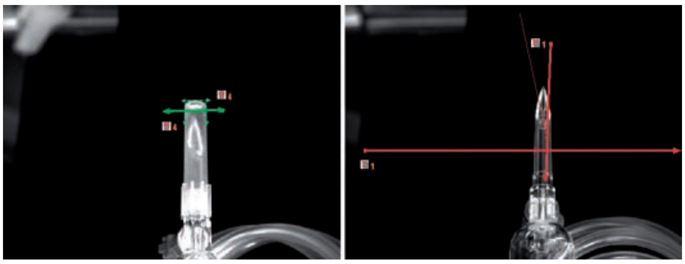
Vision Sensors Can Save Lives

Successful Introduction of Vision Technology in IV Set Production

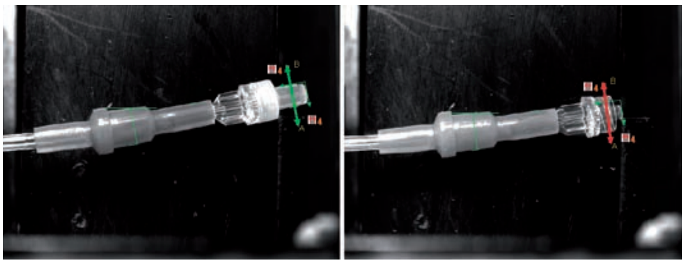
Only a few areas have requirements for product quality as high as medical engineering. A 100 % inspection is essential, because every manufacturing error not detected can claim the life of a person. Baumer's VeriSens vision sensors have proved to be powerful tools for the automated inspection.

Intravenous (IV) administration sets for gravity infusions, colloquially also called "drip," are part of the clinical standard equipment. By means of these devices, patients can be treated with nutrients or medication can be administered. While the first infusion attempts were not very promising (in 1657, a servant sentenced to death was administered a solution of *Crocus metallorum*, which led to heavy nausea and nervous agitation), today IV solutions and systems have a permanent place in the daily use, thanks to the straightforward handling and swift disposability.

The company B. Braun Melsungen AG has set milestones in the history of infusion medicine. In 1951 it developed the first devices for continuous infusions and two years later the first IV equipment made of glass. With this equipment it was possible to provide aseptic infusion solutions for one-time disposition for the first time. Extensive cleaning and sterilization became obsolete; the IV sets became commodities in the clinical environment.



The diameter of the protective cap made of transparent synthetic material can be evaluated reliably with the Baumer FEX technology



A missing protective cap securing the transparent joint to the catheter is reliably detected with VeriSens vision sensors as well

Until today these systems hardly changed. The functional principle is as easy as it is ingenious: Due to gravity, a liquid drips into the drip chamber and from there it arrives in the patient's body. The speed of the infusion can be controlled with a flow regulator. Thanks to the transparent drip chamber – in the past made of glass, today exclusively made of synthetic material – a quick visual check by the hospital personnel is possible.

Since 1953 the production methods, however, have changed fundamentally. With increasing automation several manual production steps were omitted, while the quality requirements of the systems rose. For instance, B. Braun produces 140 million of these IV administration sets for gravity infusions per year, which is more than 450,000 devices per day. A comprehensive quality inspection of these quantities can no longer be accomplished by men alone but requires the deployment of image processing solutions.

Vision Sensors for the Inspection of the Protective Caps

In Melsungen, the machines for these production quantities are developed, manufactured and automated by the company's own special purpose machinery manufacture. "For B. Braun the product quality and quantity are especially important. We inspect every detail of our products. Any manufacturing error can claim the life of a person and therefore quality is our top priority. A 100 % control has been mandatory in our factory for a long time," says Stefan Opitz, PLC technician and machine vision specialist at B. Braun.

An important inspection is the presence control of the protective caps on the connections to the IV container as well as on the joint to the venous catheter. Both areas have to be protected in particular to guarantee an aseptic connection.

With Baumer's VeriSens vision sensors B. Braun relies on integrated, powerful contour-based processing. "We tested several different devices, but it soon became apparent that VeriSens met our requirements best," states Opitz.

Measurands Enable a Secure Identification

"Within the framework of a validated process compliant with Good Manufacturing Practice (GMP) we can enter the threshold of the bearing corner radius and therefore the diameter for the detection of the protective cap. This is not possible with a pattern matching. Here, one can only define the tolerable deviation, but there are no dimensions available to monitor the exactly defined threshold. The VeriSens function 'edge distance' allows a much more stable detection and it is comprehensible for all employees involved," explains Opitz.

The integration of the VeriSens vision sensors was easy to perform. "The C-Mount option has provided us with great liberties concerning the choice of the zoom lenses," Opitz continues. "Thus, there were no constraints regarding the operating distance of the device. The laminar air current in the machines is not disrupted and even a subsequent integration into another machine is possible."

A further important aspect is the reliable identification of the characteristics. Thanks to the integrated contour processing, alternating lighting conditions do not constitute a problem. "VeriSens is a very robust tool for us that is still quickly and easily commissioned. With the inspection of the protective caps we implemented a first project and gained very positive experience. Therefore, we are now going to approach further tasks," Opitz gladly explains.

Test Successfully Passed

To be allowed the operation in the production process the Quality Control department had to be convinced. Already on the first attempt, VeriSens could prove its capability. "We had to produce several thousand IV sets to safeguard the sensor and the changed PLC program in the machines. All of the products were checked by Quality Control in line with the validation and the qualification. VeriSens recognized all of the interspersed defective parts reliably, and the machine separated all of these automatically," summarizes Stefan Opitz. Ever since, the sensors have been used continuously. In the process every IV administration set for gravity infusions is checked during production and defective parts can be detected at an early stage. When it is a matter of life and death, when every second counts Baumer's VeriSens vision sensors have already had a small but crucial share in providing the optimum care for a patient.

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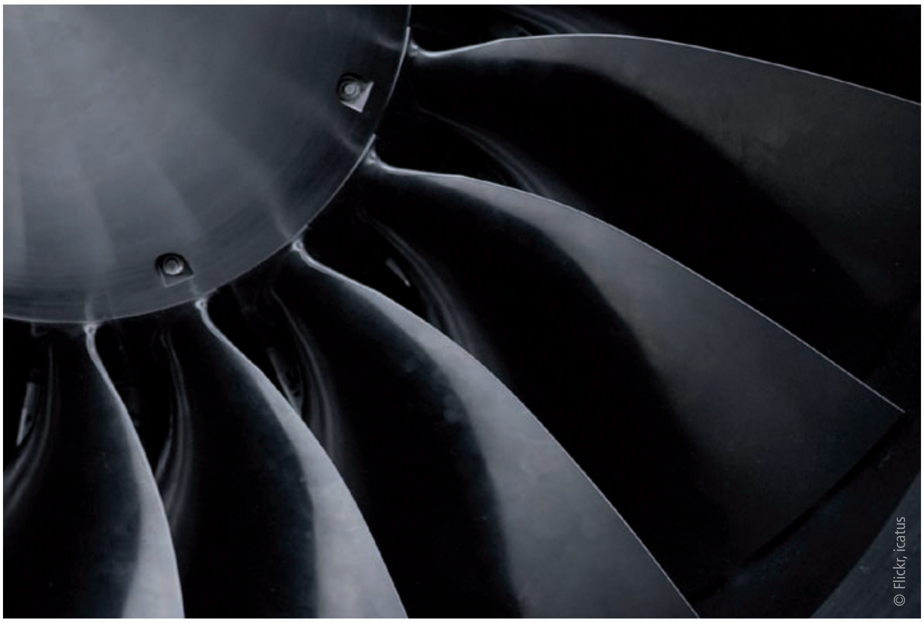
Revolutions in Manufacturing

Robot Based Quality Inspection for Metal Machining

Innovative production technologies for metal and plastics processing is the focus of the CIP (Centre for Innovative Production Systems) development and demonstration center in Dortmund, Germany. Revolutionary manufacturing methods like the high-precision metal working by electrochemical erosion, or new drive techniques and manufacturing procedures in the field of punching and forming are uniquely combined here under the same roof. Indispensable for the applicability of these new technologies for the factory floor is automated part handling as well as 100% quality control.



One of the innovative technologies of high-precision metal working represented by CIP is the PECM process (Precise Electro-Chemical Machining). For this process CIP operates a PEMTec machine with some outstanding features:
- manufacturing of components with highly complex geometrical shapes,
- machining accuracy of 2–5 micron at serial production,
- process steps roughing-smoothing-polishing in only one clamping,
- machining within undercuts,
- absolutely burr-free.

In addition to the use and the enhancement of new technologies to fulfill customized production orders CIP developments always also focus on automation of these technologies for batch production. The part handling along the whole process and the production integrated unmanned quality inspection, are two of the several important aspects of automation.

Part Handling and Inspection

An essential contribution to the areas of part handling and quality inspection has been made by Otto Vision Technology. Their system had to meet the requirements of flexibility, applicability to different part geometries and the demanding inspection tasks in the fields of metrology and surface inspection.

Due to the complexity of the task the installation of a robot based handling and inspection system was inevitable. The heart of the machine constitutes a five-axis-robot which can be flexibly adapted to the specific needs of the user while requiring only little space. Two different measurement modules are available for part inspection. As an option a module for surface inspection is provided in addition. The configuration as it is installed allows the user to execute the following tasks:
- loading of the manufacturing machine,
- part unloading after machining,
- 2D part measurement,
- 3D part measurement,
- surface inspection.

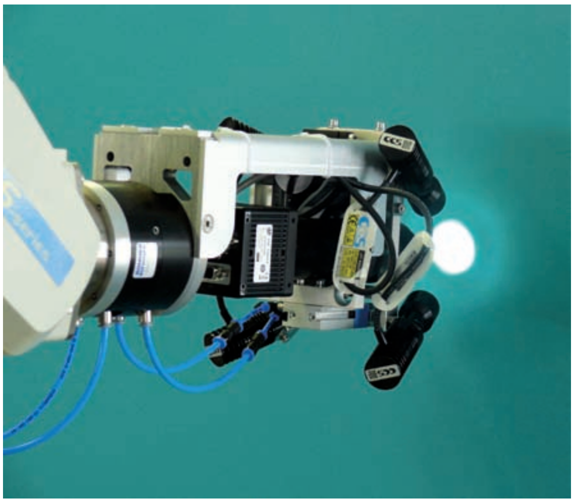
Part Loading and Unloading

For a fully automated manufacturing process it is mandatory that the machine is continuously loaded with material or pre-machined raw parts. Both, the unloading of the finished parts and the transfer to the inspection system, have to run fast and smooth.

Depending on the available cycle time, the number of simultaneously manufactured parts (multi-cavity-tool) and the accessibility of the manufacturing machine‘s operating area, a robot system can be employed for all these tasks. In case these conditions cannot be matched, additional handling systems are necessary. The applied five-axis robot features all interfaces required for the communication with the manufacturing machine and further peripheral devices.

Robot at part unloading

Robot in measurement position



Robot probe for surface inspection

Normally, mechanical grippers as well as vacuum grippers are provided for the pick and place of the parts. As an option, the gripper can be exchanged fully automated in a deposit station. For machine loading it might prove to be necessary to apply a further camera to visually guide the robot.

Combination 2D/3D Measurements

In order to meet the diverse requirements for quality inspection both, the traditional 2D measurement with backlight as well as the 3D measurement based on structured light projection, have been implemented in the robot measurement system. A decisive criterion for this decision had been that the 2D measurement of certain dimensions is often more precise than a 3D measurement, whereas the complexity of the parts' geometry manufactured with the PEMTec machine absolutely requires an additional 3D measurement.

In both measurement modules the part to be inspected is moved by the robot and positioned in front of the camera. The robot enables the inspection of the parts from different views. As an option, a temporary storing on a rotating plate can be used for 3D measurement.

The 2D measurement integrates high-end optical modules and high-performance image processing and thus allows for fast measurements down to the micrometer-range.

The measurement software of the CVS image processing systems provides tools for highly complex 2D measurement tasks, including the respective Gauge R&R.

The 3D metrology is able to capture the entire 3D geometry of the part. Afterwards a deviation analysis to CAD or other reference models can be executed and any differences occurred will be graphically displayed. It is also possible to carry out any 2D or 3D measurement or geometrical dimensioning and tolerancing within the 3D model. These measurement processes can be integrated as automatic operations in the overall process.

Surface Inspection

The module for surface inspection is designed as a compact unit with camera and illumination. Here, in contrast to the part measurement, the sample part remains immobile whereas the camera/lighting probe is moved by the robot. The core of the module consists of a high resolution GigE camera with 5 mega pixel and special front light illumination units. The integrated motor-zoom lens allows to work with different magnifications. The inspected surface is scanned via the movement of the robot. Subject to the chosen optical resolution surface defects of about 1.5 µm can be detected.

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Light at the End of the Tunnel

Combination of Intelligent Illumination and Machine Vision Ensures Reliable Automated Defect Detection

Automated paint inspection of total car bodies is still one of the major challenges in the field of optical quality control. The color spectrum of the surfaces is virtually endless, the optical contrast ranges between black and silver metallic, the surface is highly glossy, the defect catalogue covers depth defects like dents, inclusions, and scratches as well as orange peel, dirt or insufficient optical properties (DoRI – Distinctness of Reflected Image). Large smooth areas like the roof or front and rear hood have to be inspected but also areas with distinct curvatures, like the door handle cavity. It is not surprising that most of these inspections are today still done exclusively visual by highly skilled experts.

To support these experts in their challenging task of visual paint inspection light tunnels are used, allowing the inspectors to see the broad range of defects thanks to the usage of specialized optical systems. This inspection process makes use of specific contrasting illuminations. Each of the different illumination types is optimized for a specific inspection task. The combination of all different techniques leads to the optimal illumination that is mandatory for the defect detection without interrupting the production process. Smallest irregularities down to a size of 10 µ are magnified in such a way that they can be easily detected by the human eye. The company Uwe Braun made their mark in the automotive industry with such light tunnels and with the ColorMatching-Cabin. The latter is used to simulate different day light scenarios and to thus enable the detection of color variations for components and vendor parts.

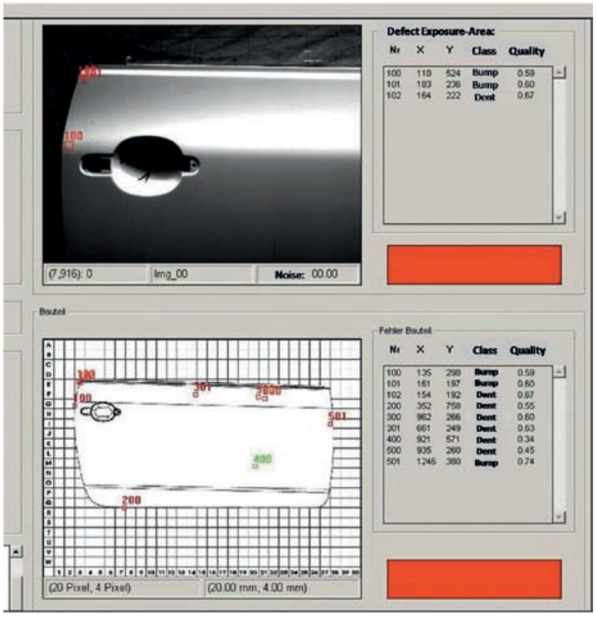
Visual inspection in total in the Uwe Braun light tunnel

Automation of the Visual Inspection

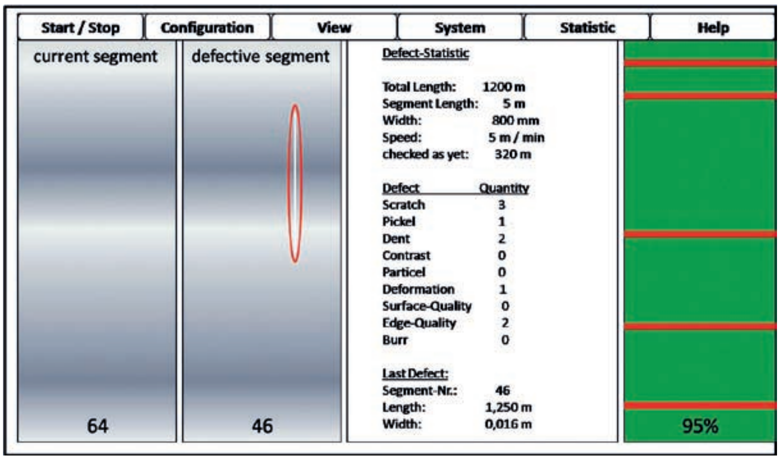
With the strong background in visual surface inspection and supported by innovative illumination engineering, today Uwe Braun has expanded their offering and is supporting a fully automated surface quality inspection with integrated sensor technology and advanced image processing software. Building on their core competence of illumination engineering, the company supports their customers individually and project related. In this way customized solutions, based on the core components illumination, sensor technology, processing unit and software platform, are configured modularly. The evaluation software with graphical user interface and image processing algorithms is designed in such a way, that it can be configured based on individual selection characteristics and customer requirements.

Intelligent Illumination Technology

The system is comprised of the three main components illumination, image acquisition and image processing. These standardized all-purpose elements are adapted to each individual application accordingly. In accordance with the requirements, the illumination and sensor technology will be either mounted separately or in an integrated sensor head at an applicable position. All illumination components are developed and manufactured in-house. They are playing the key-role within the selection of system components for a certain task. In principle, one may state: the illumination needs to accommodate the optically and physically characteristics of the expected surface defects, it has to support their detectability, or even needs to facilitate the evidence of the existence of surface de-



Visualization of surface defects on an outside door panel



The user-friendly graphical user interface supports the application-oriented system configuration

fects in the first place. An intelligent electronic illumination control unit is taking care of the optimal illumination level of the inspected surface, taking into account the background brightness, the grade of reflection, the major surface classification and the grade of contrast.

About Uwe Braun

Uwe Braun GmbH, located in the city of Lenzen at the river Elbe in the federal state of Brandenburg, Germany, was founded in 1995 and initially concentrated on development and production of lamps for exterior use and on surface inspection illumination. The product range has been continuously enlarged ever since, and today covers a large range of specific lighting solutions and systems for the fully automated optical surface inspection.

In the automotive industry, the company is setting the worldwide standard with its optical solutions for paint inspection and surface inspection in different stages of the car production. In accordance with the company's philosophy "from the coil to the lacquer-finish," a total quality management, which covers the manufacturing process entirely, is thus enabled. An early detection of defects, plus an early enough processing and eradication is supported, even before a defect can cause additional costs in one of the following production steps.

In the Process Technology Division, the company pools all know how of visual and automatic surface control, color measurement and color matching to support the customers from the automotive, steel, furniture, ceramics and paper industry with customized solutions for their individual tasks.

Modular Machine Vision System

Depending on the task and the environmental conditions, different components will come into operation: line scan or matrix cameras, 1-chip or 3-chip cameras, standard or high-resolution. Depending on the complexity of the task, the image acquisition of the inspected objects will be done either in gray scale or in color. The user friendly and to a large extent self-explanatory graphical user interface supports the application-oriented system configuration and provides all relevant process related information in real time. For the communication with higher-level systems, integrated interfaces and bus systems are provided. They allow the freely configurable integration of the system into any process environment. With respect to process-security and system-protection, a number of different user levels have been implemented which can be adapted to reflect the individual corporate and/or organizational structure.

Defect Detection by Classification

Initially, any detected surface defect will be identified, marked and statistically registered as being an "event." Via defect classification, an event will then be classified into a category. Standard events are, for instance, bumps, dents, scratches, inclusions, contaminations, burrs, color deviations, structural differences, etc. Classified events will be evaluated depending on their size (diameter or lengths in direction x and y, respectively), their position and their level of contrast, and will then be marked and treated as defects according to the system configuration. With the help of the teaching-mode, the event database can be extended by a user-defined number of additional events.

Optical character recognition (OCR), barcode and data matrix code identification are implemented as well. Any additional characters can be added to the classifier's database.

In the teaching-mode, the user can teach one or more test samples as reference samples for the next inspection batch (i.e. when changing the decor in an automated surface coating line for medium-density-fiberboards). For standard inspection tasks (i.e. inspection of monochrome and planar surfaces), the system provides the operator with a number of predefined parameter sets and thus allows operation even without the necessity for any previous teaching sequence.

100% Control

The new fully automatic image processing inspection system completes the product range of the Uwe Braun GmbH and closes the gap between the previous pure visual inspection and the industry's need for a fully automated, reliable 100% impartial surface inspection. Intelligent illumination is as important as a pre-condition here as it is for the purely visual surface inspection.

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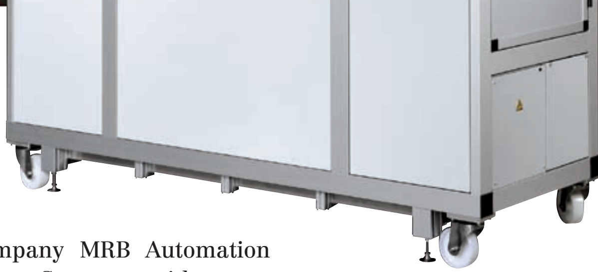
On the Right Track

Fully Automated Inspection System for OLED Patterns

Organic LEDs work more energy-efficient and provide images richer in contrast than the liquid crystals of the LCD technology. More and more, they are found in flat screens and backlights as well as in mobile phone and mp3 player displays. Before deployment the OLEDs undergo a fully automated electric and optical inspection at the Fraunhofer Institute for Photonic Microsystems.



The development of OLEDs is moving forward. Currently, the organic lighting units are mainly applied in display technology. However, researchers are already working on the vision of luminescent wallpapers that change their color on demand and serve as monitors. The OLED technology's advantage: They consist of ultra thin organic layers and are therefore very flat. Therewith, production on flexible substrate is possible so that flexible displays and electronic paper can be manufactured.

Since 2007, the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden possesses four prototypes and pilot production lines for the manufacture of OLED lighting units. In order to complete these lines, the Fraunhofer Institute tasked the company MRB Automation based in Ilmenau, Germany, with a system for the electrical and optical inspection of OLED substrates. Therewith the Institute will develop the COMEDD (Centre for Organic Materials and Electronic Devices Dresden) into the leading European centre of OLED technology.

About MRB Automation

MRB Automation, Ilmenau, Germany, is a mechanical engineering company which specializes in measurement and inspection systems, automatic adjustment machines, machine vision solutions, assembly systems and the manufacture of customized machinery for a wide variety of uses. Among MRB's customers are companies of high repute from the following fields: automotive supplier, sensor technology, biomedical technology, plastics technology and metalworking. MRB is also in co-operation with research institutes and universities.

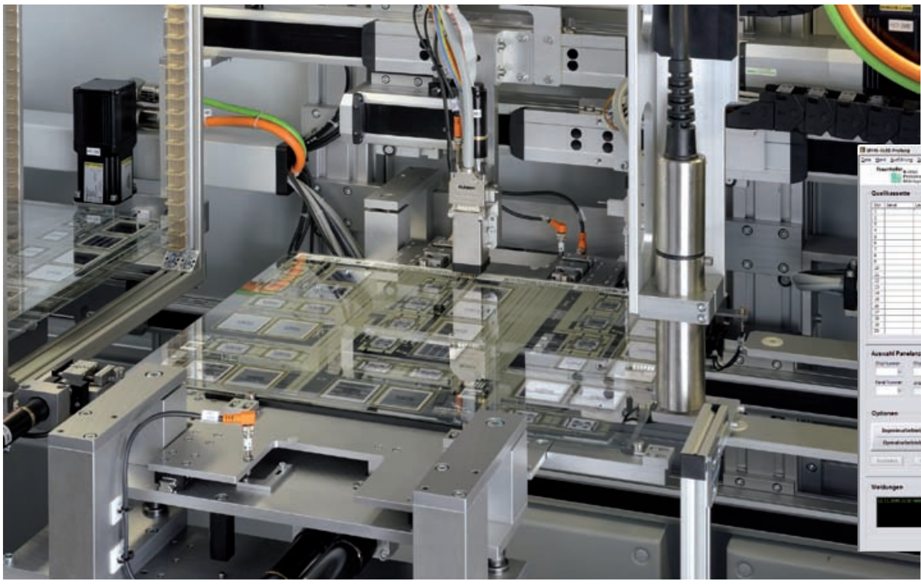
Inspection of Panels Distributed in Any Order

The IPMS has commissioned MRB Automation to design and produce a fully automated system for the electrical and optical inspection of OLED substrates. The task was to create a universal system permitting the inspection of panels distributed in any order across a substrate area measuring 47 x 37 cm. The measurements required for the panels are illuminated area, luminance, chromaticity coordinate, homogeneity, dark spots and bright spots. Besides these features, the electrical parameters must be tested: the forward voltage and current and the inverse voltage and current. All the parameters for the substrate are stored in databases and transmitted to the inspection system, and they accompany the test results transmitted back.

First, the substrates are stacked in 20-layer cassettes, and then sent through the system in turn. A robot arm removes one substrate at a time from the cassette and places it in the inspection area. Once the substrate has been lined up centrally, all the panels on it, which may number up to 120, are contacted by two moveable contact heads and thus inspected. After each individual inspection, an inkjet printer will, if required, print inspection code on the panel just tested.

Sequence Control with LabView

A user interface based on LabView has been programmed for the convenience of the operator. After the cassette of substrates to be tested has been inserted, and the cassette ID entered, the data relating to the particular substrates is loaded from the database and the inspection procedure begins. Progress is represented visually to the user and all the test results can be viewed and checked immediately. The tolerances permitted for each individual inspection are stored in the database and can be edited by the



◀ OLED substrate in inspection position

▲ User interface for the inspection system

user if necessary. For the optical parameters, a calibrated luminance and color measuring systems created by Technoteam, Ilmenau, Germany, is employed. The optical features tested are displayed on a separate monitor, so that the user is kept informed of the progress at all times. Likewise, all electrical measurements are made with calibrated systems which guarantee the necessary accuracy at all times. For the purposes of maintenance and testing of the systems, the user can select the password-protected "engineer" mode; this allows every individual function to be tested. In addition, all operating states are logged into a journal.

The inspection system has been in use at the Fraunhofer IPMS since October, 2009 and plays a vital role in manufacturing checks and quality assurance.

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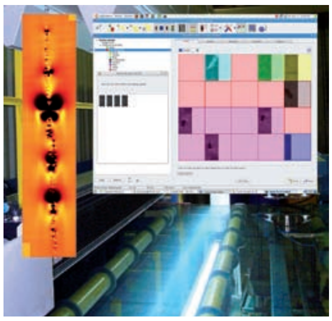
360° Full View Bottle Inspection at 400 Bottles/Min

Mettler Toledo CI-Vision announces the new 360° Full View bottle inspection system which utilizes four cameras to produce a seamless complete image of the bottle being inspected. The new system can inspect full or empty bottles of plastic or glass, in various colors and sizes up to 1.5 liters at line speeds of up to 400 bottles per minute. As a bottle passes through the enclosure at any orientation, it triggers four cameras to capture images of the bottle simultaneously. The analysis software performs the routines that calculate the bottle's coordinates and determine whether the correct label has been placed in the proper position on the bottle.

Mettler Toledo CI-Vision Inspection
Tel.: +1 630 446 7700 · www.mt.com

Visual Defect Detection

Cognex launched VisionPro Surface, a vision software package for inspecting the surface of materials. It combines a new visual defect detection and classification technology with a simple user interface to enable accurate defect detection, classification, and surface texture assessment during the manufacturing process. Unlike traditional surface inspection technologies, VisionPro Surface works by monitoring the visual appearance of the material. Using statistical analysis, VisionPro Surface automatically identifies potential defects in the material's surface, and classifies the defects into groups based on similarity in contrast, texture and geometry. Manufacturers in industries such as solar energy or material coating and other converting industries can achieve a quick return on investment by monitoring process efficiency, and eliminating defective material before it is shipped to customers.



Cognex Corporation · Tel.: +1 508 650 3000 · info@cognex.com · www.cognex.com

Software for Glue Bead Inspection

Omron will release the software FlexXpect GlueBead to inspect glue bead with high accuracy. The glue status is inspected right before gluing to secure the sealing of the electric device. The software is equipped with Omron's original automatic outline scanning function. It calculates the glue status even for complex glue paths by automatically scanning the glue outline, glue width, gap width and for wrong glue paths. Also, a more stable inspection can be performed by the execution of HDR (high dynamic range), an image processing tolerant to the use environment. By preparing a dedicated glue inspection interface and result display screens, the company made possible, easier inspection setting and error analyses with less man-hours spent. The software can be used by installation to the Omron Vision System Xpectia.

Omron Electronics GmbH · Tel.: +49 2173 6800 0
info.de@eu.omron.com · www.industrial.omron.eu

Perfectly Bottled

Process Optimization through High-speed Imaging

Process optimizations lead to increase of production efficiency and therewith the increase of the companies' gross profit. The first step in process optimization is to learn about the process itself that means monitoring the process and collecting data. In case of high processing speeds, this is not an easy task. That is the reason why more and more companies invest in innovative vision solutions with high-speed cameras.

Manufacturing companies have to use every chance to optimize their processes. They must reduce the number of rejects, minimize down times, maintain product quality on a high level, increase production, and consequently enhance productivity. The beverage bottlers are faced by these interdisciplinary challenges as well. They are confronted with several interference factors: Sporadic shutdowns without obvious reasons to be seen or irregularly occurring production problems, i.e. bottles that are not properly sealed, damaged edges on bottles or unlabeled or mislabeled containers. Production errors cause a high reject rate and therefore corresponding follow-up costs. During retooling to another product much material is lost, it is time-consuming and risky. Often, product switch is not worthwhile for small quantities, which reduces the production line's flexibility. The optimizing measures are carried out according to the principle of "trial and error." Their impact can only be verified over time, while the line is running. Such problems can be remedied by modern high-speed camera systems. They contribute by enhancing process efficiency and consequently lead to substantial cost savings.

Small Cause – Big Effect

Technicians who are responsible for production systems must sometimes feel as if they are groping in the dark, especially when they have to find causes of malfunctions. And there are many possible causes for disruptions: Parts that get caught on guides or the vibration of grippers or other parts of the equipment. Blocked feeds, damaged parts or labels which stick in the wrong places can also paralyze whole production lines. Because of high processing speeds, it is impossible to recognize and eliminate such problem areas just like that. Consequently, valuable time is wasted and unnecessary rejects are produced.

High-speed camera systems make it possible to precisely analyze and document manufacturing processes. Recording rates of several hundred frames per second (fps) deliver insight into the fastest processes. The analysis of single frames makes causes for disruptions visible and comprehensible, so that they can be rectified quickly and efficiently.

With Promon beverage bottlers get a vision solution for process optimization

Increasing Efficiency

Many manufacturing systems could be run at a higher frequency than specified. However, practice shows that the majority of production lines are run at even lower speeds than the manufacturer of the system guarantees. The reason: concerns about the sustainability of quality and stability also at maximum speed. Through such unnecessary restriction of

Promon Scope, AOS Technologies' high-speed camera system, is specifically designed for the requirements of industrial production

capacity, companies relinquish a high degree of productivity. In this regard too, high-speed cameras create measurable value. They monitor, analyze, and document the fastest production processes, and enable the optimization of relevant parameters, and consequently an increase of the throughput rate. This makes it possible to use plants more efficiently. Sometimes, even the acquisition of new process lines becomes unnecessary.

In production, increasing or reducing throughput by only a few percentage points can make the difference between profitability or excessive production costs. In this regard, the fact that unnecessary overhauls can be avoided through the use of high-speed imaging systems is of high importance. In today's practice, systems are being overhauled when disruptions with unknown causes occur. Overhauls are expensive and don't guarantee success. If, on the other hand, production interruptions can be made transparent by a detailed analysis of the processes involved, the necessity of an overhaul can be assessed and carried out only if deemed essential.

Requirements for Daily Operations

Even though they are well suited for use in the manufacturing industry, high-speed cameras have so far only found marginal use in this environment. Thanks to a wide range of solutions suited for industry use, these systems are now capturing the market. Solutions must fulfill the following requirements:

- **Intuitive operation:** Users are generally not camera specialists but responsible for operative maintenance.
- **Solution for industrial needs:** All components, like camera, computer, cables, and power supply must be able to withstand tough industrial everyday use. Experience shows that products from the PC and consumer electronics world are poorly suited fort this kind of use.
- **Instant application:** In case of production problems, the camera system must be immediately usable. Cumbersome assembly work, including the search for parts or the set-up of wiring is undesirable.
- **High-capacity:** Although high-speed camera systems impress with powerful features regarding frame rates, resolution, and color fastness, in an industrial environment another feature comes to the foreground: the continuous recording of images, sometimes for several hours. It is often essential to record a complete processing cycle.
- **Cost effectiveness:** Investment costs for high-speed camera systems usually have to pay for themselves after only a few applications.

Beverage Bottling – Processes under Control

The use of a comprehensive AOS Technologies camera solution at a beverage bottling plant proved that the use of a high-speed imaging system can be profitable within the shortest of time periods. The reason for infrequently incompletely sealed bottles was determined in short order and documented by means of images. The use of caps with undamaged sealing lips made a complete overhaul of the bottling system unnecessary; incompletely sealed bottles became a thing of the past.

Thanks to the use of the high-speed camera system, it is now possible for the bottler to document the production process as well as the produced goods. It also enables the company to accommodate increasing requirements for traceability and batch management. The AOS Technologies high-speed camera system also enables the documented elimination of bottles with damaged openings. Thus, customers will not be receiving any crown-capped beer bottles with chipped glass parts.

In addition, the company benefits from a measurable reduction of poorly positioned labels. Before the documented optimization of the labeling system, labels would sometimes get caught or end up askew on the bottles. These unnecessary rejects could be eliminated by applying the simplest measures.

Considerably reduced retooling times are also of significance. Thanks to the recording and visualization of difficult processing stages by high-speed cameras, critical settings – for example of feed rates – can be targeted, adjusted, and verified. The significantly shorter retooling times enable the company to retool the production system for the processing of smaller lots as well. Since the introduction of the high-speed cameras, the beverage bottler benefits from more flexibility and better utilization of his production system.

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Perfect Fit

Non-contact Handheld Gap and Flush Measurement

Gap and flush measurements on car bodies constitute an essential quality criterion for every production process in the automotive industry. As simple as this measuring problem may sound, the devil is in the details, as it is so often the case. A clear and comparable measurement is made difficult due to bent reference surfaces; the fear of scratches on freshly painted surfaces turns every tactile measurement method into a potential hazard; and undercuts require the optical measurement systems' ability to peer around corners.

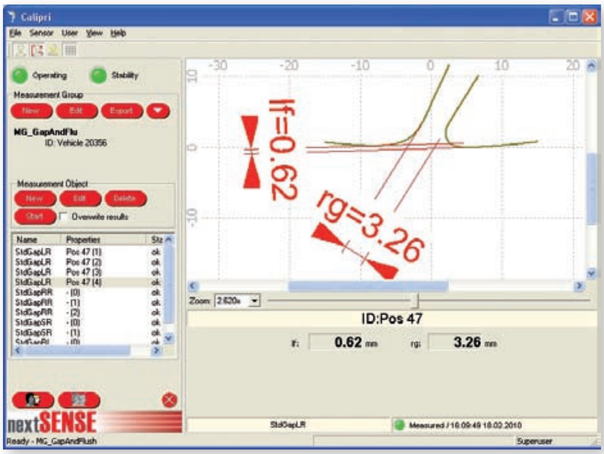
The tilt angle between device and surface is recognized and used to correct each measurement so that the final result is a true normal section, independent of the sensor's alignment

The Austrian high-tech company NextSense GmbH has now developed the smart solution for this measuring task. Calipri Gap is the first opto-electronic gauge world-wide that is able to measure profiles of any shape and calculate the relevant resultant features handheld and non-contact. Operation is simple: The measuring device is moved around the measuring point by hand, while a laser and a camera scan the profile from various sides. The intelligent image processing-based system continually assembles the individually measured segments, delivering a complete profile curve of both the inner and outer surface of the gap, even at edge angles of more than 90°. A precise alignment of the handheld sensor is not necessary for this process. The tilt angle between the gauge and the surface is determined by a patented procedure. In this way the result of each measurement is corrected, so that the final result is a true normal section, independent of the sensor's alignment. Also the distance between probe and object does not have to be kept exactly constant: Acoustic signals and a friendly female voice provide continuous feedback to the user as to how well he has positioned the sensor in relation to the gap.

Automatic Feature Calculation

A complete measurement takes around 5 seconds. Calipri Gap automatically evaluates the quality of the recorded measurements and eliminates any unqualified data. The measurement result is thus to a large extent free from operator influences and is hence objective and reproducible.

Also the calculation of the features from the recorded data is done in a smart way. The measurement data are segmented into the elements of outside surface, edge radius and inside surface using the shape features; and based on that, the gap & flush measurements are calculated. The measuring device provides exact and reproducible measurement values even in the case of bent outside surfaces. In doing so, the user can determine whether he prefers the left or right side as a reference. A symmetrical variant, however, can also be selected. Likewise, the measuring direction for the gap width can be defined through the outside surfaces; or it can



Based on the automatic segmentation of the measurement data into the elements of outside surface, edge radius and inside surface gap and flush measurements are calculated

be performed parallel to one of the two inside surfaces.

Customized Measurements

Modern car bodies, though, with their streamlined designs often feature a lot of special cases, like tread plates, gaps for door and window seals or trunk lid seals, which do not conform to the pattern of a standard gap. Calipri also offers a solution for such special contours: With its “AnyProfile” special measuring program, well-nigh any contour can be measured by the user himself, who can then transmit the recorded data to NextSense’s customizing service. Based on this data and specifications of the desired dimensions to be calculated from them, a custom-tailored measuring module will be configured that the user can download on his device and work with.

Yet Calipri is not only able to administer measurements, it can also do so with the corresponding metadata like car body numbers and/or measuring point numbers, vehicle types and suchlike. Volume and type of this data can be freely defined by the user. All measurement data can be grouped into datasets related to the measured object. Templates with predefined metadata can be prepared for recurring measurement processes. Furthermore, the admissible threshold values of each measurement value can be furnished, which, if exceeded, trigger an alarm. A range of formats like XML and CSV are available for export of data into downstream CAQ systems.

Integrated Self-test

A multi-level authorization concept protects all configurations from unintentional altering by less experienced users, thus facilitating the greatest possible flexibility and the simplest operation at the same time. A reference standard included in the delivery with an integrated self-testing and comparison function allows for a regular check and monitoring of the measuring equipment according to a whole range of quality standards.

Among those customers who are using Calipri Gap already with great success is Magna Steyr Fahrzeugtechnik AG, who uses it to test the perfect fit of body components for the Mini Countryman by BMW.

For Railway Technology: Calipri Wheel

By the way, the big brother of Calipri Gap is called Calipri Wheel. It is used for the maintenance of rail vehicles – for instance: to examine the wear of railway wheels on a regular basis. Yet this does by no means exhaust all possible application cases. The Calipri is an all-rounder that measures rails and switches, brake discs and gear wheels; it is also able to determine runout, wheel clearances or diameters and has established itself as a jack-of-all-trades in many an assembly hall or service workshop.

But that is a different story …

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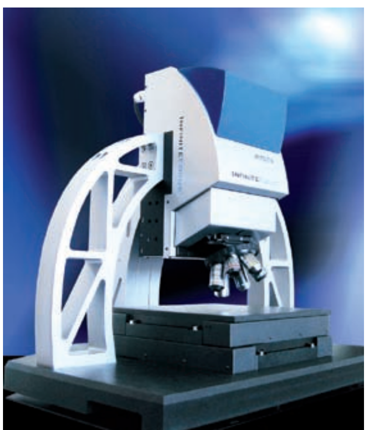
Non-contact

Product Overview: Optical Coordinate Measuring Technology

The pressure is rising: More and more, customers require products which are proofed for 100 %. Manufacturers who realign themselves with regard to their measurement equipments and who plan new investments find here an overview of the current optical coordinate measuring technology. The advantage: The operation mode is non-contact.

A separate measuring system for each measuring task - this is a thing of the past. Today, due to economic reasons, measurement equipment must be applicable in a versatile way. That's why **Aicon** (www.aicon.de) developed a new **system concept for the measurement of 3D coordinates**: MoveInspect Technology. It is based on a unique modular system that allows the user to combine the individual components such as sensor, probe and computer with the appropriate software in order to meet the exact requirements of a measurement task. Thus MoveInspect Technology masters an abundance of measuring tasks with just one single system, like probing, tracking and targeting. Dynamic movements can be acquired with a frequency of up to 1,000 Hz while measuring an infinite number of points over a variably long period of time. Fast analyses deliver the basis for direct, on-site decisions, for example for corrections in running production.

Also, **Alicona** (www.alicona.com) focuses the versatility of its optical 3D measurement system for the quality assurance in laboratories and production lines. The measurement device InfiniteFocus combines the functionalities of dimensional measurements, surface analysis and characterization. It measures geometries with **steep flanks and strong roughness** with a vertical resolution up to 10 nm. Moreover, the patented SmartFlash technology makes sure that Infinite Focus adapts itself to the different specimens' surface properties. This means that compounds and other topographies with different materials and therefore varying reflection properties are determined with high-resolution.



The coordinate measuring system Fetura VMS from **Linos** (www.linos.com) is characterized by high measurement speeds. The measurement device is controlled by the metrology software PowerMetrix which provides tools for precise image processing, coordinate data acquisition, and geometric calculation. Heart of the Fetura systems is the precise and fast digital zoom lens. It is able to zoom across its 12.5:1 magnification range in less than 1 second. The result is **lower inspection cycle times** and magnification accuracy and repeatability. Together with the segmental controllable LED ring light, the transmitted light or coaxial illumination or the stripe light projection for reflecting surfaces, the device ensures precise measurements for different objects.

GOM´s (www.gom.com) industrial 3D metrology mates over the complete product cycle: from determining material constants over the speed-up in tool making, the try-out and the dynamical analysis of machine tools up to a series-accompanying production control. The optical analysis techniques are oriented to the specific industrial production processes and ensure high process reliability in every production step. The corresponding software Inspect for shape and volumetric analyses of 3D coordinate data has been optimized continuously in a close collaboration with companies from the automobile and aerospace industry.

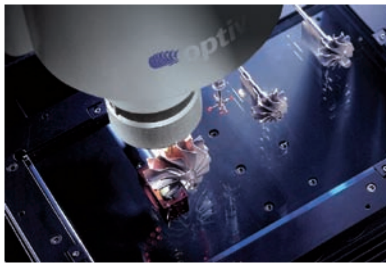
The automatic measuring machines from **MRB** (www.mrb-automation.de) are implemented in order to accomplish a **100% part control in production lines**. The 3D machines already installed in measuring rooms can be relieved. According to the required task the positioning, diameter, circularity and concentricity of drill-holes and the evenness of surfaces can be determined. For the different tasks, MRB developed a modular concept whereby the measurement and proof technique and the required handling systems are suited in an effective way to the corresponding job definition.

All measured values are digitally recorded and statistically analyzed and can then be transferred via interfaces as input data for an overall system, e.g. QDAS.

In order **to measure precision tools, Z-Mike**'s (www.z-mike.de) devices work with a HeNe laser beam. Therewith the fly circle (effective cutter's diameter) and concentricity are determined. The measurements occur with an even as well as an uneven cutting edge number by using algorithms and on the tools' adjusted images. The laser micrometers are not subject to temperature influences and can be installed in-line.

Both Combined: Optical and Tactile

The Optiv product series' multi sensor technology from **Hexagon Metrology** (www.hexagonmetrology.com) combines the optical and tactile measurement in one system. Adjusted to the 3D geometry, the material and the specimen's surface properties as well as the precision requirements, the measurements are realized **with a suited sensor: with contact or contact-free**. Thereby, the systems support multi sensor mea-surements with a video sensor, a tactile sensor, a TTL (trough-the-lens) laser as well as an innovative chromatic white light sensor. The basic device can be upgraded with all available sensors according to the modular conception.

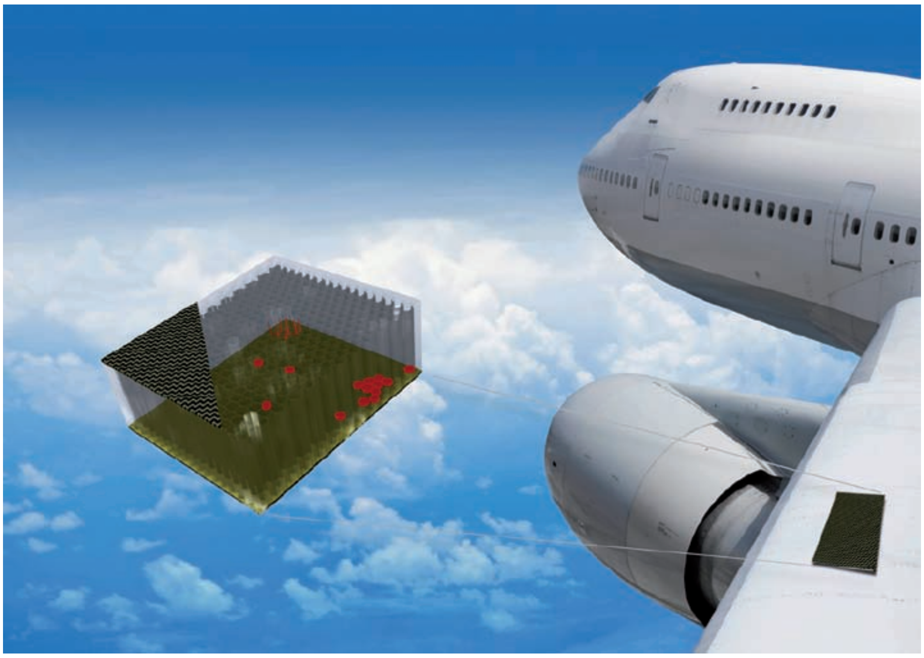


The hybrid 3D metrology combines high-resolution optical 3D scans with tactile measurement data in a single task. Only with the integration of the data in the software PolyWorks from **InnovMetric Software** (www.innovmetric.com, European representatives: www.duwe-3d.eu), **the advantages of coupled measurement systems can be exhausted**. The new interim version PolyWorks V11 offers a number of new possibilities, like a temperature adjustment through material specifications or a new multi-functional display which can be freely configured. In real-time, it provides information, like feeler coordinates, information on min and max errors, standard deviations and shape and profile defects of features.

Deep Insights

3D THz Imaging in Quality Control

Terahertz (THz) imaging allows insights into the structure of non-metallic objects like high performance composites with the goal to identify manufacturing defects that were hidden from detection so far. Terahertz imaging also enables a precise characterization of surfaces and coating thickness - even if the surface is covered by other materials.



Until a few years ago, the generation of useable THz radiation was only possible at high efforts. The radiation was therefore used mainly for scientific research purposes; the systems have been elaborate and really expensive. Meanwhile, however, also the cost-efficient employment of Terahertz radiation for industrial purposes is possible. The all-electronic approach in combination with the synthetic imaging technology leads to ultra-short measurement times in combination with excellent image quality. This allows the use of this still rather young technology in a production environment as well as in a quality control laboratory. The introduction of the SynView products results in a significant reduction of production costs by limiting scrap and by minimizing the amount of used material. Another advantage is the ability to create products of even higher quality because users now have the ability to investigate the exact inner structure of their high-performance composite products.

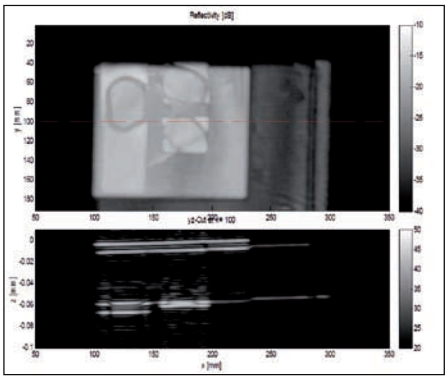


Fig. 1: Top: maximum reflectivity; bottom: cross-section along the a red line

What Is Terahertz Radiation?

Terahertz radiation is the electro-magnetic radiation in a frequency range between millimeter waves and microwaves on the one end, and infrared radiation on the other. The former are used by radios, satellite TV, and mobile phones, while the latter are used by infrared cameras and heat radiators. In numbers, Terahertz radiation has a frequency between 100 Gigahertz (GHz) and 10 Terahertz (THz). Many electrically non-conducting materials like paper, plastics, and composite materials are transparent for THz radiation. It is therefore possible to look into closed containers and packages similar to using x-rays. In addition, the material composition and material interfaces can be analyzed precisely.

THz Radiation Is Safe

A decisive advantage of THz radiation in comparison to x-rays is that this radiation is completely safe. X-rays are ionizing and therefore are accompanied by significant health risks. THz waves on the other hand exhibit extremely low photon energy so that there is no danger that chemical bonds might be broken up and that the examined material is chemically altered. Also, the emitted power is very low leading only to insignificant heating. Therefore, in principle, the path is clear to make use of THz radiation also in close vicinity to humans.

Quality Control: Hidden Defects

One of the main applications of THz imaging is based on the possibility to look "inside" the objects, i.e. to get a full three dimensional image of the inspected object. The THz data allow the visualization of individual layers from within the object, which makes it possible to identify defects like holes, cracks, missing glue, and so on.

The THz image of a test sample (fig. 1) clearly shows the different layers, the area of the glue (and where it is missing), and the holes within the specimen. The

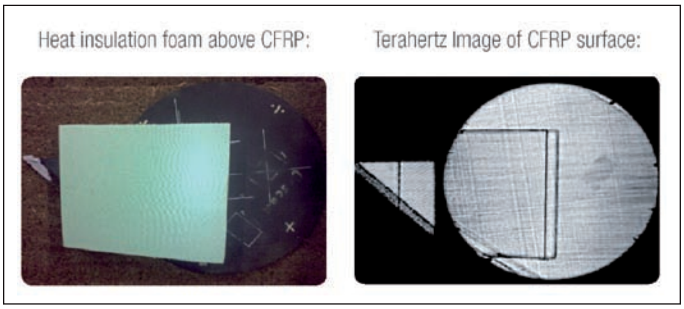


Fig: 2: Example for hidden surface characterization

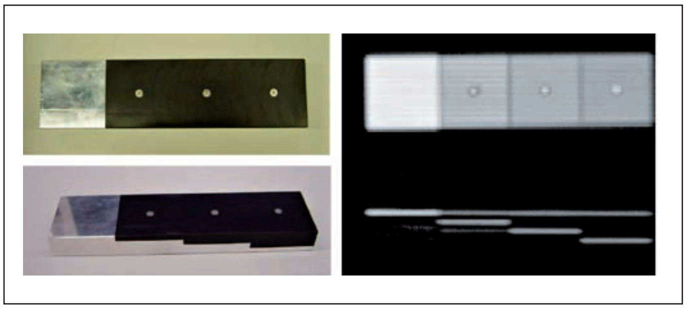


Fig. 3: As can clearly be seen, even the thin layers are analyzed precisely

top THz image shows the maximum reflectivity and a red line. At the position of the red line, a new THz image was generated out of the THz data which is shown in the lower THz image. The different layers are clearly visible.

Analysis of Hidden Surfaces

THz waves easily transmit almost all non-conducting materials like paper, plastic, wood, and composite structures like foam. It is therefore also possible to characterize the areas hidden by these structures. One example is the surface characterization of carbon-fibre-reinforced-plastic (CFRP). Two different CFRP samples were placed below a block of Syrodur foam (fig. 2). As can be seen, the top layer structure of the CFRP is clearly visible in the THz image. There is no difference in visibility between the parts that were not hidden and the ones hidden by the foam. Similar results can be obtained for many other materials.

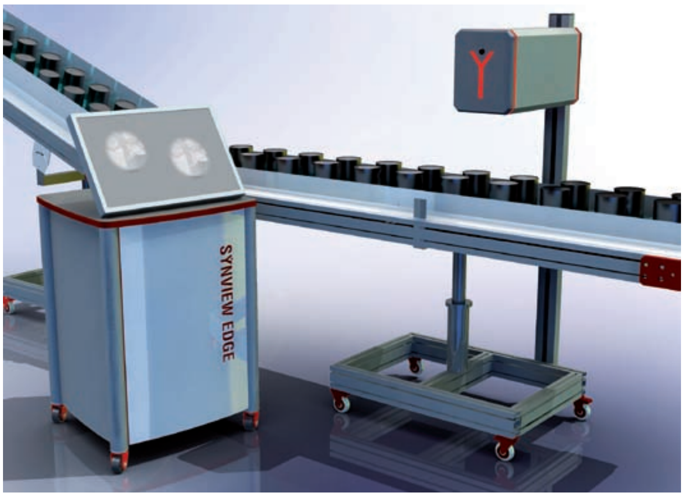


Fig. 4: Multiple SynViewHeads combined in the SynViewEdge system

Thickness Control

The thickness of single coatings can be measured with a precision of better than 100 micrometer. In the example here (fig. 3), the plastic coating on metal tubes is measured using the SynViewHead 300 (fig. 4). The image shows the top view and the layer structure. As can clearly be seen, even the thin layers are analyzed precisely. For this application only a simple off-the-shelf SynViewHead is required. Controlling the thickness of the coating can save large amounts of material and therefore can lead to significant cost savings.

SynViewEdge

For industrial applications in a production environment, the SynViewEdge system is used. This system is based on multiple SynViewHeads combined with the proprietary Synthetic Viewing Technology. SynView customizes the SynViewEdge THz imaging system for professional applications to optimize the performance-cost relationship. For each application there is the right configuration to ensure the required imaging speed combined with the necessary image quality while keeping the cost low. Operator-friendly software for the specific production environment is provided with each system.

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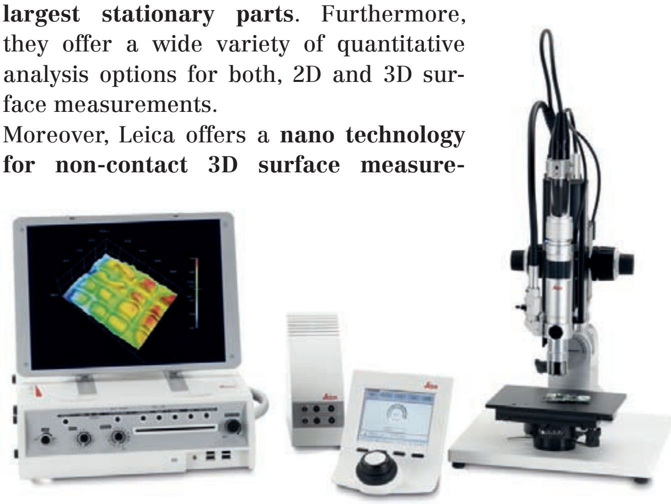
An Eye for Detail

Product Overview Microscopy

Whether 2D analysis or 3D surface measurements: The industrial quality assurance makes high demands on microscopic imaging and processing. Innovative microscopes open up new possibilities in respect of velocity and mobility. Find out more about the microscopy branch's news in the following overview.

The industrial quality inspection requires **fast and reliable image results**. In order to uphold this demand the Digital Imaging Business Unit of **Jenoptik** (www.jenoptik.com) expands its microscope camera family ProgRes by new USB models. With a resolution of up to 5 megapixel the USB cameras of the CMOS line deliver high-quality images with live frame rates of up to 30 fps. From now on, the ProgRes CF and MF cameras with USB 2.0 interface are available and provide a faster live imaging in SXGA resolution at stable 15 fps.

Also, **Leica Microsystems** (www.leica-microsystems.com) optimized its new digital working microscopy series in respect of velocity and image quality. The digital microscopes DVM5000, DVM3000 and DVM2000 reach with their streamlined zoom optics extremely difficult-to-access surfaces and allow the **non-destructive inspection of even the largest stationary parts**. Furthermore, they offer a wide variety of quantitative analysis options for both, 2D and 3D surface measurements.
Moreover, Leica offers a **nano technology for non-contact 3D surface measurements**. The dual core 3D measuring microscope Leica DCM 3D combines the confocal microscopy, interferometry and color imaging in one sensor head. The device analyzes micro and nano structures of technical surfaces in a fast and non-contact way, down to 0.1 nm.

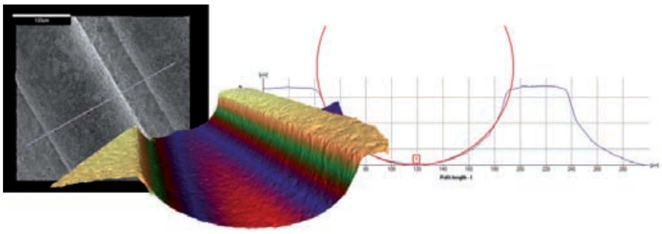


In order to compare measuring results with CAD, **Vision Engineering** (www.visioneng.de) offers its video measuring microscope Falcon. Therewith, a **comprehensible profile comparison** can be generated. Recurring measuring sequences are registered as a macro in the first measurement. After including the required dimensions and maybe prompts for the personnel, this device measures as fast as a fully automatic system.

For its videoscope systems, **Olympus** (www.olympus.de) now presents new long scope models with an effective length of 10 m and an external diameter of 8.5 mm. They allow users to **view wide areas when observing inside large cavities**, such as large pipes, fire tubes or tanks. Thereby, interchangeable lenses offer universal magnification possibilities and viewing angles. The LED lights ensure a bright illumination in order to detect smallest defects as well. The device works with the machine vision software WiDER (wide dynamic extended range) that improves details in shadowed and outshined areas to generate images with a well-balanced contrast over the whole field depth area.

The white light interferometer NewView 7100 from **ZygoLot** (www.zygolot.de) inspects parts with diameters from 1 mm to 130 mm and runs numerous tests with them. These include the measurement of evenness and roughness, as well as shape deviations. Alike, recessed areas, angles, radii and cones can be measured. Furthermore, **grinding structures and signs of wear** are determined, layers and edges are analyzed. The results are highly reproducible. In the case of evenness tolerances, the company guarantees a reproducibility of 0.5 µm.

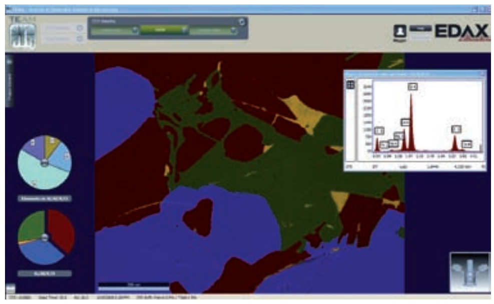
To **turn a scanning electron microscope (SEM) into a true surface metrology device**: This task is solved by the Software MeX from **Alicona** (www.alicona.com). Using stereoscopic images the software automatically retrieves 3D information and presents a highly accurate, robust and dense 3D dataset which is then used to perform traceable metrology examination. The results are obtained irrespective of the SEM magnification providing metrology at macro and micro levels. With its modular design, the analysis modules allow measurement of profile, roughness, area, volume and Z height. All measurements are traceable, can be calibrated and conform to ISO standards.



Not only SEMs, also traditional light microscopes can be extended to a 3D surface metrology device. With the measurement principle of the white light interferometry, the 3D data can be determined over the microscope's entire field of observation with high precision. Therefore, the **Gesellschaft für Bild- und Signalverarbeitung** (www.gbs-ilmenau.de) offers under the name smartWLI-microscope a **turnkey solution to upgrade existing microscopes**. A special measurement module realizes high precision 3D measurements of surfaces with a resolution in the nm range. In order to evaluate these data, there are several tools, like roughness analysis (DIN/ISO), determination of step heights, particle analysis or logging. Typical application fields are the surface characterization of different roughness (wafer structures, mirrors, crystals, and metals), the determination of step heights and the precise measurement of curved surfaces, e.g. micro lenses.

The **interface between the microscopes SEM and light microscope** is the correlative microscopy by **Carl Zeiss MicroImaging** (www.zeiss.de/mikro): Shuttle & Find. This solution connects upright and inverted light microscopes with all Zeiss scanning electron microscopes. Within a few minutes, it is possible to transfer a sample from one system to the next. The sample can also be sent to another lab equipped with an SEM. In the SEM, the areas of interest of the sample examined are automatically relocated in a matter of seconds. In addition to numerous analyses which are based on separate images from light and electron microscopes the images of the two different instrument platforms can be precisely overlaid and correlated to x-ray maps to deliver further information.

Electron diffraction instrumentation provides analytical intelligence that allows users to obtain higher quality and more reliable results. Therefore, **Edax** (www.edax.com) launches its team **EDS system with smart features**. It offers an interface that allows an open layout and maximizes the display area for what really matters the results. The monitoring and operating conditions of the system are available with Smart Diagnostics. Optimal set-up of the image collection occurs with Smart Acquisition.



Microscope Stages and Components

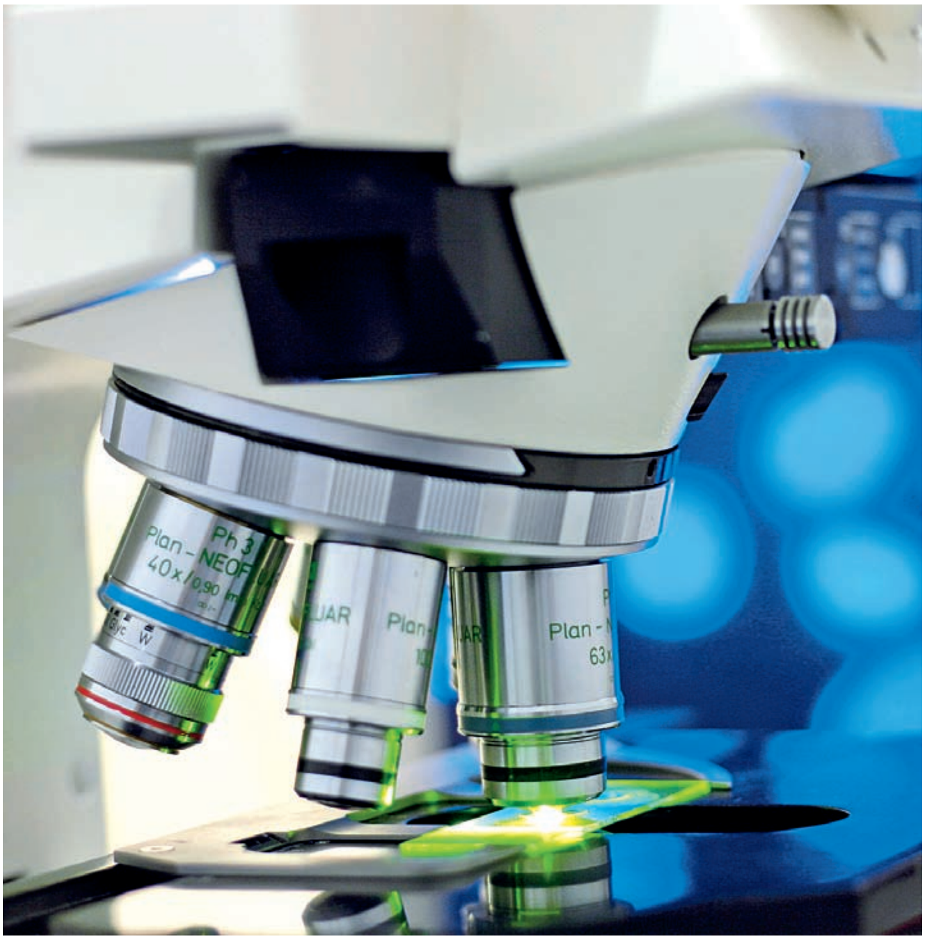
In the fields of microscopy and surface inspection, in many cases a **dynamic and precise focus adjustment in the direction of the optical axes** is required, e.g. in case of auto focusing on the surface topography or on different focal planes in order to support PC-based 3D structures. Especially for the focus vernier adjustment, the company **Physik Instrumente** (www.physikinstrumente.com) provides piezo actuators in its portfolio which can be suited in a flexible way to different requirements. Directly assembled at the lens they are able to change their focal planes in screening, e.g., to compensate the differences in specimen's level. Time-critical test series and high throughput rates are no problem for the piezo actuators due to their dynamic skills. More applications can be found in the field of 3D imaging: PIFOC-Z-drives for lenses can be built very small and stiff. They react in fast response times and position precisely even in case of long traverses. In applications where the specimen and not the lens is moved, e.g. in the phase contrast microscopy, the company has adapted piezo Z drives as well.

Whether in research and development, in material testing or in life science: A precise and ergonomic working on the microscope decides on the results' quality. That's why **Märzhäuser Wetzlar** (www.marzhauser.com) develops and produces manual and motor-driven micro position systems as well as the microscopy's control in close collaboration with manufacturers and research institutes. The customized microscope stages are characterized by their **precise and smooth run**.

Malignant Cells?

Spectral Image Processing and Improved Image Contrast Facilitating Diagnosis

The scientific cancer research is based on the microscopic monitoring of cells and tissue. Now, methods of spectral image processing improve the image contrast and support medical diagnostics via software solutions.



The cell is the origin of all life. However, many diseases and tumors also originate in cells. When cells and tissue show abnormal changes, pathology is required. Pathologists cut wafer-thin slices from tissue samples taken, which they then analyze under the microscope in order to answer the crucial question: is it a benign growth or a malignant tumor? Microscopic analysis is a highly responsible task, as the findings decide the subsequent medical action to be taken and the appropriate treatment to be selected.

Cancer Cells Glow

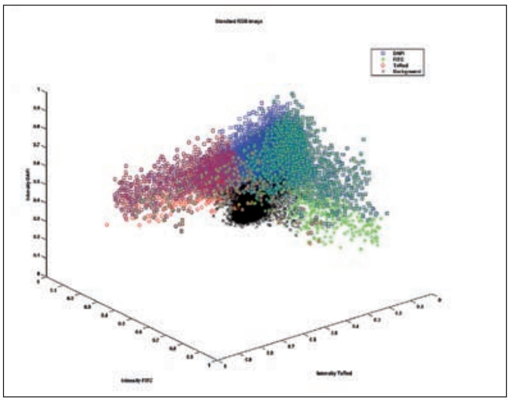
Technological progress opens up new opportunities in disease research. Fluorescence microscopy makes use of the fact that some substances in human cells react to excitation light by emitting fluorescence. Through the use of multiple fluorescent labeling, cell components, DNA regions or whole DNA sequences can be identified from the different colors. In breast cancer patients, for instance, doctors are particularly interested in chromosome 17 and HER2 status, which promotes tumor growth. Using multi-color fluorescence in situ hybridization (M-FISH) pathologists can count the number of positively labeled (malignant) cells and color-code them. The cell nucleus, for example, is colored blue, chromosome 17 green and the HER2/neu receptor red. However, labeling and visualization is also the greatest challenge in M-FISH microscopy: the color signals of some pixels overlap cannot be clearly localized and make analysis more difficult.

Spectral Separation

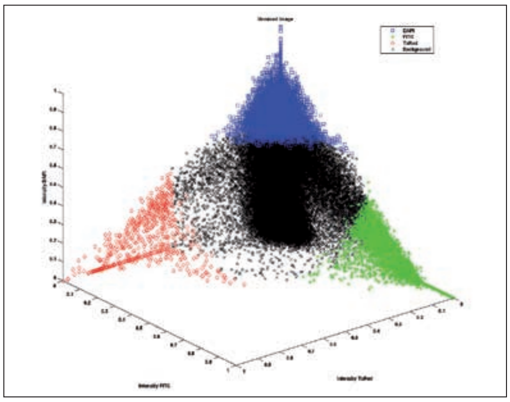
The researchers Thomas Arnold and Martin DeBiasio, both specialists in spectral image processing at CTR, the Competence Centre for Advanced Sensor Technologies, have tackled the problem. Arnold: "The M-FISH results are like a cloud with a large number of color pixels that overlap in places, making it difficult to identify and classify the colors. Pathologists therefore need a great deal of experience and have to be extremely meticulous. We have developed a system that separates the data three dimensionally as it were." The three-dimensional arrangement of the probes is particularly interesting for the two CTR researchers: „The color perception of each pixel is also affected by its neighbor. This is why we have broken down all the spectra into their constituent parts. The algorithm deciphers the cloud and separates the pixels," explains Thomas Arnold.

System setup with camera, light source, filter and visualization

Not only did they take a new approach in software development, but also adapted the hardware. Martin DeBiasio: "We used special microscope components. In addition to a highly sensitive camera, we opted for a particular light source that would excite the fluorescent signals better and a tunable filter to record the individual images in a very narrow wavelength range."



The cloud of coded color labels makes analysis more difficult



A special algorithm separates the cloud and makes the individual color segments clearly visible

Improved Image Contrast

The two researchers succeeded in proving that spectral image analysis can improve the image contrast and thus increase the image quality. Their tests showed that 22 % of the color pixels could not be clearly identified in classic color images (RGB). Spectral image analysis enabled them to reduce the percentage to 1.1 %. "Doctors can now identify pixels that they could not previously see with the naked eye. As the images are more accurate and analysis conditions standardized, the technology can help the doctor to make the diagnosis," say the researchers.

The two multispectral specialists were assisted by Dr. Franz G. Würz from the Pathology Institute at Klagenfurt regional hospital. „Without the tissue images Dr. Würz made available to us and his medical expertise, we would not have been able to carry out our analyses," adds DeBiasio.

Their results have appeared in several scientific publications and the two young researchers have also attended international conferences. In the meantime their work has been progressing. They intend to isolate not just three but five or more colors from the cloud in the future.

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Coaxial Illumination Systems for Infrared Applications

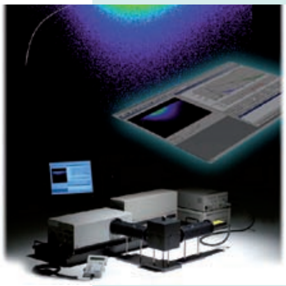
The Swiss illumination manufacturer Volpi has expanded his range of standard products with high-power LED coaxial illumination systems for infrared

applications. All CIS (Coaxial Illumination System) and ACIS (Advanced Coaxial Illumination System) versions are now available with infrared-LEDs. These systems use special high-power IR-LEDs with a wave-length of about 875 nm. Due to Volpi's high quality standard the illumination level is completely homogeneous. The advantage of a long-waved infrared-range is the marginal interaction with the material. Because of this characteristic, IR coaxial illumination systems are capable of transmitted light inspections of coloured materials or inspections of printed or draggled surfaces.

Volpi AG
Tel.: +41 44 732 4343 · mail@volpi.ch · www.volpi.ch

Fluorescence Lifetime Spectroscopy System

Since many years the streak technology is well established as the high-end method for time-resolved fluorescence spectroscopy. It is employed in a range of complete measurement systems Hamamatsu is offering. The brand-new C10627 streak detector is the successor of the well-known Streakscope detector.



It offers two big quantitative improvements along the above mentioned themes: The streak sweep repetition rate is further improved by a full order of magnitude. This will give 10 times shorter measurement times in case of very weak samples. The maximum photon counting rate is improved by a factor of about five. This allows shorter measurement times in case of samples with stronger emissions. Both improvements extend the capabilities of these systems even further, allowing efficient measurements even in most demanding applications.

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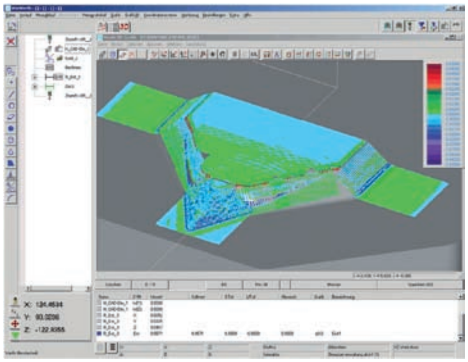
Auto-Focus Sensor for Topography Measurement



The Werth 3D-Patch sensor from the company Werth Messtechnik enables surface topography measurement with an auto-focus sensor that is fully integrated in WinWerth software. This provides simple, fast three-dimensional surface data collection. The Werth 3D-Patch sensor performs an auto-focus routine over the entire field of vision of the camera. With a single pass along the optical axis over the desired measurement area, many measurement points are captured within a few seconds. The density of the measurement points and the evaluation area can be defined easily using WinWerth software. One advantage of this method is that it does not require any additional hardware, so that this sensor presents a less expensive alternative to the classic confocal microscope or white light interferometer.

Werth Messtechnik GmbH
Tel.: +49 641 7938 0
mail@werthmesstechnik.de · www.werth.de

Is the crisis finally over?

9%
Yes, definitely. Business is picking up again.

55%
Probably yes. Things are looking good.

18%
Rather not. We are only experiencing a temporary peak.

18%
By no means. It will be getting worse first.

Quelle: www.inspect-online.com

Poll

Profilometer Changes between Measuring Methods

With the contactless, optical profilometer Plu Neox from Sensofar, Schaefer Technologie has introduced a device that combines interferometry, confocal technology and reflected light microscopy in one compact measuring device. The 3D measuring microscope with the patented display technology allows a change between the various measuring methods within a few seconds, enabling a broad range of different samples to be measured. The Neox was developed in order to perform contactless measurements of surfaces with different features in the micro and nano range. The range of applications extends from measuring roughness on extremely smooth surfaces in interferometry to measuring extremely rough, unreflective surfaces with flank angles of up to 70° in confocal mode.

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Interview with Dr. Ralf Christoph, CEO and Owner of Werth Messtechnik, Germany

INSPECT: Dr. Christoph, measurement equipment with multiple sensors plays a predominant role in the product portfolio of Werth Messtechnik. In your opinion, what further development is to be expected for coordinate measurement in the future?

R. Christoph: At Werth Messtechnik, with a history based on optical measurement equipment, we have placed the focus on multi-sensor coordinate measurement since the early 90's. In those days, that meant first of all the combination of image processing and a tactile sensor in one single machine. As it is hard to predict the future, we have also been guided by the needs and desires of our customers. This is one of the reasons why we were able to introduce an applicable sensor, the Werth Fiber Probe, to measure micro-features many years before others. In 2005, at the Control Show, Werth introduced the first coordinate measuring machine with an X-ray tomography sensor. This machine was, by the way, also equipped with multi-sensor technology. It is very likely that tomography and micro-feature measurement will become more important in the future. Fiber probes, in combination with optical sensors, will measure micro-features with a precision better than 100 nm. X-ray tomography will assume a larger role in the field of plastic injection molding. However, it is expected in the near future that most machines will measure with both optical and tactile sensors.

One of the challenges for the use of optical coordinate measurement technologies is the fact that the results cannot be directly compared to the data obtained by tactile measurements. Are there any "translation tools" for the user?

R. Christoph: Since the introduction of image processing sensors into the CMM world about 20 years ago, Werth has been practically alone in this market in Germany. Therefore, it was very important for us to prove the comparability of optical measurement results to tactile measurements. Along with the development of accurate and traceable sensors, we also promoted the expansion and application of guidelines and standards for tactile coordinate measurement technology into the optical field. New guidelines of VDI/VDE 2617 and finally also of the international standard, ISO 10360, allow a comparison of the specifications of different measuring machines and sensors. For critical measurement tasks, for instance those with a strong demand for accuracy better than 1 micron, multi-sensor technology helps by calibrating and adjusting the optical and tactile measurements with one machine on master pieces. However, in practice, different sensors in one measuring process are mainly used for different features.

Also, in the field of computer tomography, multi-sensor technology helps. Micron accuracy traceability is provided with pure tomography for simple to measure sphere standards or simple parts. With multi-sensor technology this is also provided for measurement results of work pieces with difficult to measure geometries and material. With the Werth Tomoscope, measurement accuracies of a few microns can be proven without the use of multi-sensors. With multi-sensors, this can be reduced to less than 1 micron.

How important is the image processing for your measurement systems and what are the user requirements regarding the software?

R. Christoph: For all Werth machines, image processing is traditionally a main element. With over 20 years of experience, it is one of the reasons for our leading position in the market. This sensor type is very precise and extremely fast. Flexible illumination systems, like the Werth MultiRing and reliable, precise contour image processing software which can be easily used, for example with the Werth AutoElement, are very important for the user. With continuous development, Werth strives to extend its leading position in the market. Patents serve to prevent fast emulations from competitors. For example, with our patented OnTheFly technology, it is possible to measure 10 or even a 100 features, or rather positions, per second. Our experience in image processing also plays an important role in the development of our tomography systems.

Looking into the future over the next five years: in which areas do you see the biggest technical challenges and where do you expect the most important economic opportunities?

R. Christoph: Tomography and micro, or rather nano, measurement machines are additional fields, but they will do more to complete the field of classical tactile and optical measurement than take the place of it. It will become more and more important to offer complete tailored solutions to our customers than to sell machines "off-the-rack."

We would like to close with a personal question: You received your PhD and made your post doctoral theses at the Friedrich-Schiller-University in Jena, yet today you are the manager and entrepreneur of a successful medium-sized enterprise. What made you decide to change from an academic career to an entrepreneurial one?

R. Christoph: Actually, after nine years of academic research and teaching at the university, I regarded the work as head of the development department for Werth as only temporary mainly intended to broaden my horizon. During the recession in 1992, I got the chance to work as an entrepreneur. In comparison to the university, I have not been limited to only the development and publication of ideas. I also received the chance to translate ideas directly into practical applications. For me, it is a great experience to see the development of an idea and after some years of development, work with a team to see a new coordinate measurement machine with tomography sensor which is appreciated by the users. A medium-sized company offers an ideal platform for this because there is almost no bureaucracy. Young engineers and natural scientists in this environment have an interesting field of activity with the chance to transfer ideas into reality. On the other hand, at Werth I did not lose the connection to academic work. Many co-operations with research institutions have contributed to the success of the company. Therefore, Werth and the Werth foundation support the work of young scientists, for instance through scholarships.

Dr. Christoph, thank you very much for this interesting discussion.

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- Machine Vision Basics: Contour-based Pattern Matching
- Technology Focus Thermography
- Bin Picking, Robot Vision, Seam Tracking
- Identification by Vision Sensor
- Robot-guided Optical Metrology
- Product Focus Equipment for the Photovoltaic Industry
- New Camera Interface USB 3.0
- Interview with Dr. Norbert Stein, Vitronic

and much more

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