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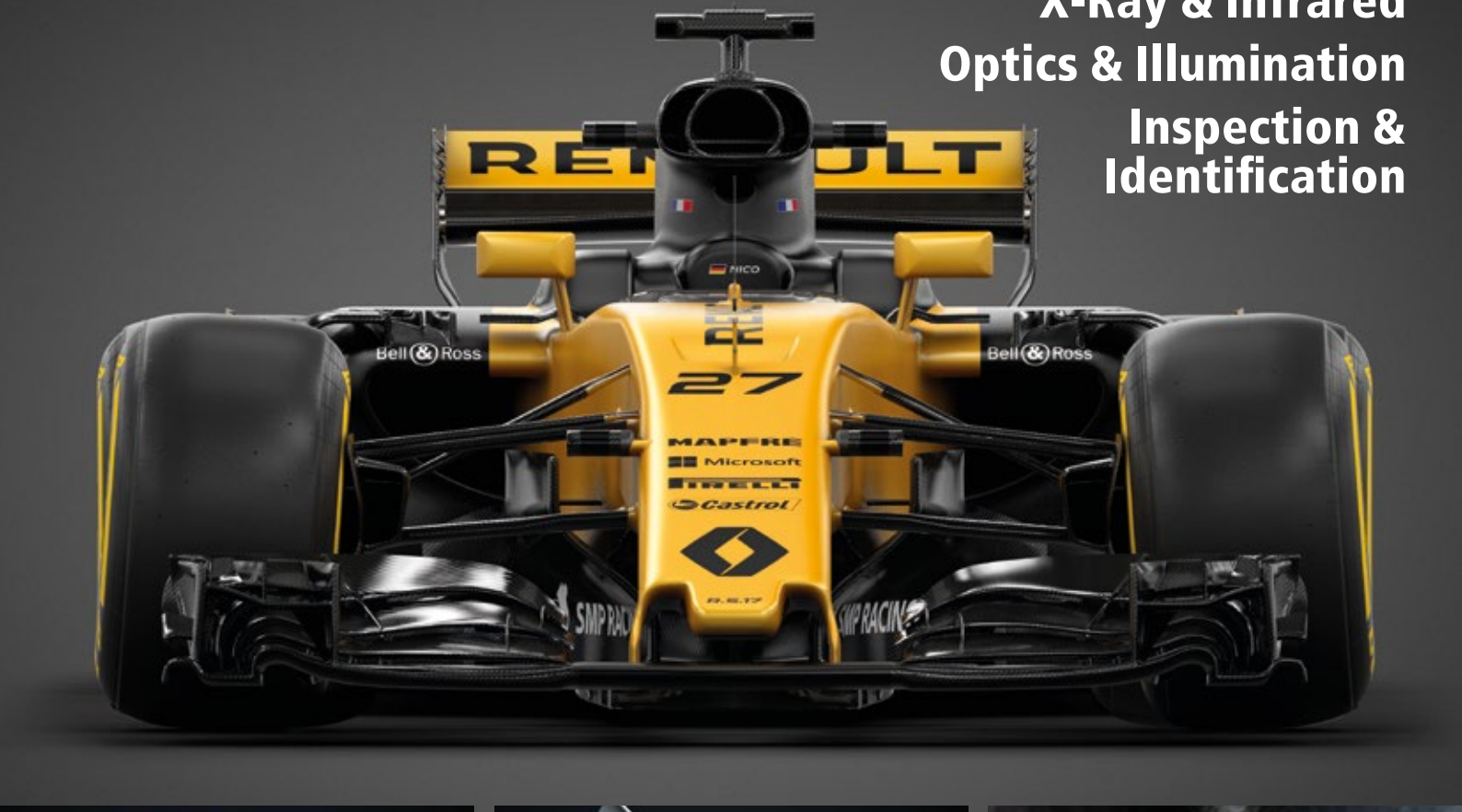

Computed Tomography at Renault F1 Team

Liquid Lens Telecentric Lenses Tap New Potentials **TECHNOLOGY**

Increase Productivity with Automated Quality Control **APPLICATION**

Vision Technology Helps to Realize the Potential of Industry 4.0 **INTERVIEW**

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At Racing Speed

Life at racing speed: digitalization rules the world and makes everything faster, every day. Be it in private life or in the industry – nowhere you can go without at least a broadband Wi-Fi connection and/or 4G LTE availability. It speeds up our daily business, and it speeds up inspection processes. Advanced imaging systems even help to digitize our planet. In the context of the IoT and Industry 4.0, testing and quality control are becoming faster and more efficient, be it due to digital X-ray and CT in racing car manufacturing, high-speed thermal imaging, or the automation of inspection processes directly at the production line. First and foremost, the digitization of entire manufacturing processes increases time to market. And here we are again, aimed at racing speed. It is reassuring to know that some of the most progressive technologies are used to preserve a tradition that encourages taking some timeout: the consistency of beer quality is secured by a highly sensitive spectrometer measuring the beer color.

I recommend you take your time (and maybe have a beer) to read the all analog inspect international print magazine to discover the latest trends and achievements in vision technology. Yet, if this doesn´t satisfy your digital demands, you are more than welcome to immerse in the e-paper or browse our website at www.inspect-online.com.

Enjoy, and see you soon on industrial vision‘s fast lane at Control 2018!

Yours sincerely,

Sonja Schleif

Contents

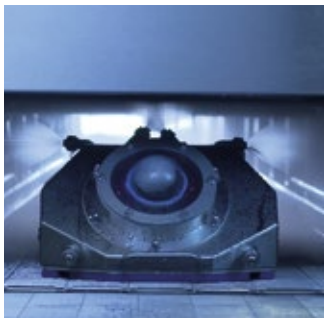

Photo: Fraunhofer IVV Dresden

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Odos Imaging Acquired by Rockwell Automation

Odos Imaging Limited (Scotland), a specialist developer and manufacturer of 3D time-of-flight cameras for industrial applications, was wholly acquired by Rockwell Automation. The acquisition enables Rockwell Automation to strengthen its sensing portfolio and positions it to continue to be the leader in machine safety. Odos Imaging Limited will report into the Architecture & Software (A&S) organization, specifically the Safety, Sensing & Connectivity Business led by Lee Lane, vice president and general manager.

Odos Imaging will continue to market its current portfolio of industrial 3D cameras and support existing customers in their application development from the company's offices in Edinburgh, Scotland, as well as maintaining participation within the automation community through attendance at trade shows, conferences, and as a member of industry wide organisations.

www.rockwell.com

VDMA: Machine Vision Continues on the Fast Lane

According to current surveys, in 2017 sales of the German machine vision industry rose by 18% as expected. This corresponds to €2.6 billion. For 2018, the industry forecasts a turnover growth rate of up to 10%. "VDMA will present the exact figures in June. But one thing is already clear: The machine vision industry achieved record sales also in 2017 and will keep up its growth course," says Anne Wendel, head of the VDMA sector group Machine Vision, on the occasion of the Visison CEO Roundtable.

For eight years, the European industry has seen record turnover and growth figures. Machine Vision meets current trends. The reason: Not only is this key technology increasingly applied in the global race for automation in classical industry sectors, it is also perpetually conquering new fields of application. Standards, connectivity and easy integration as well as digitalisation remain growths drivers. Embedded Vision and Machine Learning are opening up completely new areas and will provide the sector with fresh growth impetus.

www.vdma.org

Edmund Optics Acquires Itos

Edmund Optics announces the complete acquisition of Itos GmbH in Mainz. The company will be a 100% subsidiary of Edmund Optics Inc. and will function as „Itos – A Division of Edmund Optics".

The Itos-Gesellschaft für Technische Optik mbH has been producing optical components since 1993, including filters and polarizers. With currently 24 employees and more than 700 customers, Itos is a successful company and for Edmund Optics the ideal complement to the existing product portfolio. The product range of Itos will be perspectively expanded and integrated into the global sales activities of Edmund Optics. At the same time, this investment strengthens Edmund Optics' presence in Europe and forms the basis for expanding a manufacturing base within the region to serve European customers even better.

www.edmundoptics.de

Embedded Vision Alliance Announces Keynote Speakers for 2018

The Embedded Vision Alliance announced the keynote speakers for the 2018 Embedded Vision Summit, which will take place May 22 to 24, in Santa Clara, California. Legendary inventor Dean Kamen and globally renowned computer vision expert Dr. Takeo Kanade will take the stage at the 8th annual Embedded Vision Summit, which is the industry's only event focused exclusively on deploying computer vision in systems, applications and devices.

More than 1,200 computer vision professionals are expected to attend the three-day event, which attracts a global audience of companies developing vision-enabled products, both at the edge and in the cloud. The event features industry innovators, top technologists and engineers who are creating "machines that see" for a wide range of industries including automotive, entertainment, healthcare, manufacturing, retail, robotics and security.

"Computer vision is becoming one of the most important technologies of our era, enabling products that are safer, more capable, easier to use and more autonomous, in applications that impact virtually every industry," said Jeff Bier, founder of the Embedded Vision Alliance. "The Embedded Vision Summit is designed to inspire and empower developers to incorporate visual intelligence into all types of systems. I am delighted to welcome two of the world's leading innovators, Dr. Takeo Kanade and Dean Kamen, as keynote speakers for the 2018 Embedded Vision Summit, and look forward to hearing their unique perspectives on how computer vision is being used to transform lives and industries."

www.embedded-vision.com

Antares Vision's New Software Development Centre Is Open

Antares Vision announces the establishment of a Software Development Centre in Galway, creating 53 jobs in five years in Computer Vision and Artificial Intelligence. The project is supported by the Irish Government through IDA Ireland.

The company specialise in Computer Vision Systems where cameras and sensors capture and elaborate images at high speed to identify possible defects on products. Antares Vision designs, produces and installs inspection track and trace systems for security, traceability and regulatory requirements in the pharmaceutical sector.

The company's new Software Development Centre in Galway will have a strategic focus on developing new software tools to enhance capability in Antares Vision system by utilising Deep Learning applied to Computer Vision. Antares Vision will establish initially at the Galway Technology Centre at Mervue Business Park (Wellpark Rd) and is expected to hire more than 50 employees in five years. The new operation will have a mix of roles including junior and senior software developers and researchers.

www.antaresvision.com

Stemmer Imaging Acquires Data Vision

Stemmer Imaging has acquired Data Vision by means of an asset deal effective January 31, 2018. Data Vision is a highly specialized provider of imaging and machine vision solutions in the Netherlands. This acquisition further strengthens the position of Stemmer Imaging in the Benelux countries. Data Vision, a business unit of Batenburg Mechatronica B.V., is one of the most established brands in Benelux's imaging and machine vision industry and has been successfully providing machine vision components, systems and solutions for many years.

"The acquisition by Stemmer Imaging is the logical next step in serving this market segment," says Harm Hanekamp, managing director of Data Vision. "By being part of the Stemmer Imaging-Group, Data Vision will reach the next level and we can now follow our customers into Europe and benefit from Stemmer Imaging's larger product range, and superior level of competence. Our corporate cultures are very similar and we know each other very well. This will strengthen services available for customers in the Benelux countries who will have access to the support and security they need to continue to develop their vision applications with our help," concludes Harm Hanekamp.

www.stemmer-imaging.de

Xilinx Appoints Victor Peng as President and CEO

Xilinx announced that its board of directors has appointed Victor Peng as president and chief executive officer, effective January 29, 2018. Peng will become the fourth CEO in Xilinx's history and takes the helm of the global market leader of programmable semiconductor products at a time of increasing momentum and opportunity.

"Victor is unique in his ability to translate vision and strategy into world-class execution and has an incredible ability to inspire and lead transformation. He has been the architect of Xilinx's innovations for the past decade and will move the company forward with the speed required to capitalize on the opportunities in front of us," said Dennis Segers, chairman of the board of Xilinx. "Victor is a proven leader with exceptional business acumen and a deep, unwavering dedication to customers. The BOD is thrilled to appoint Victor CEO as the company enters its next chapter of expanded innovation and growth."

www.xilinx.com

Record Revenue and Earnings: Zeiss Continues Growth Trajectory

In the past 2016/17 fiscal year (ended 30 September 2017), Zeiss increased both its revenue and earnings to a record level: revenue rose by 10% to €5.348 billion (prior year: €4.881 billion). At €770 million, earnings before interest and tax (EBIT) were significantly above the already high level of the previous year (615 million). The EBIT margin has increased to over 14%. Order intake grew by a healthy 12% and is now at €5.625 billion, underscoring the growth ambitions of the technology company.

"All four segments – Research & Quality Technology, Medical Technology, Vision Care/Consumer Products and Semiconductor Manufacturing Technology – are either at or above their target returns and have made a positive contribution to the most successful fiscal year in the history of Zeiss," said Prof. Dr. Michael Kaschke, President & CEO of Carl Zeiss AG, at the annual press conference in Stuttgart. "This development was not and is not just a matter of course. Rather, it is the result of the tremendous efforts made by all employees and partners over a long period of time. The consistent implementation of the strategic Agenda has now made a real impact and significantly increased competitiveness. Thanks to investments in cutting-edge Innovation and Customer Centers, global partnerships and strategic expansions, we have focused entirely on the needs of our customers," said Kaschke, explaining the company's strategy.

www.zeiss.com

Computed Tomography at Renault Sport Formula One Team

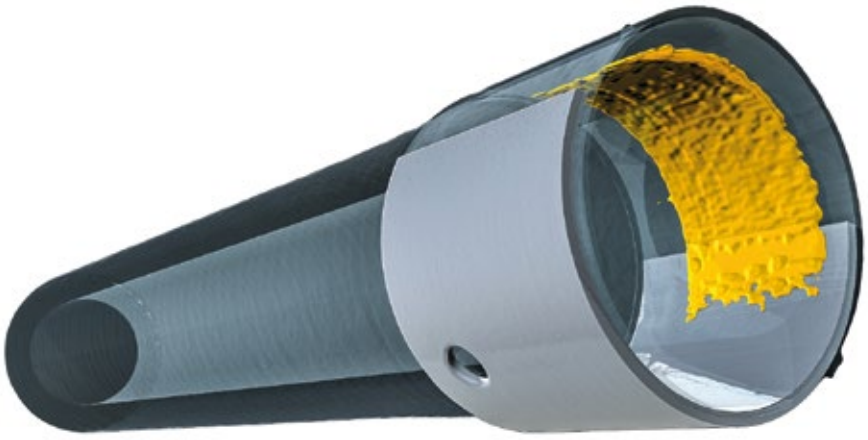
Digital X-Ray and CT Are Replacing other Methods of Non-Destructive Testing in Racing Car Manufacturing

The use of a universal X-ray system with sophisticated CT capabilities is optimizing the inspection processes at Renault Sport Racing. The diverse vehicle parts and components are inspected more reliably and effeciently than ever before, resulting in improved manufacturing and preparation processes.

At the end of 2015, Renault announced their return to Formula 1 racing. They reacquired the team which had been racing under Genii Capital as the Lotus F1 Team since 2011. So, since the start of the 2016 season, Renault is back behind the wheel, as Renault Sport Formula One Team. 2016 brought about the announcement of the successful launch of a technical partnership between Renault Sport Formula One Team and Yxlon International, global manufacturer of X-ray and CT systems for industrial applications. Yxlon has since provided the Renault Sport Technical centre in Enstone with a premium version of its industrial X-ray inspection system, Y.MU2000-D, equipped with a Variofocus tube, high-dynamic radioscopy (HDR), and computed tomography (CT).

Volume Graphics then supplied their software package, VGStudio Max 3.0 Complete to allow the team to create 3-dimensional, CT reconstructions, analysis, and detailed component visualizations. These new additions have contributed to a significant increase in the capabilities and quality of Renault Sport Formula One Team's test laboratory.

According to non-destructive testing (NDT) expert and departmental technical director, Adrian Talbot, the system's numerous testing capabilities and sheer quality will allow the reach of the X-ray system to expand to a variety of related applications. Gradually, other methods of NDT will be phased out and replaced by digital X-ray and CT. The MU2000-D in particular, checks all the boxes when it comes to quality assurance in both the preparation stage and between races. Its flexible design also enables it to test a wide range of components and parts of varying sizes and complexities. This system meets the demands of Formula 1 racing faster and more reliably than before.



© Volume Graphics

Delamination with an impact on stability and safety of the steering column.

In the following sections, Adrian introduces three applications of the MU2000-D in Renault Sport Racing that have led to the optimization of manufacturing and preparation processes:

Steering Column

The steering columns in motor vehicles are critical safety components that directly connect to the steering rack. There are no mechanical fortifications and therefore, the junction of the two parts relies solely on the structural integrity of the bond during assembly and the densification of carbon materials in the production process.

At Renault Sport Formula One Team, we initially used CT imaging technology to aid in the ultrasonic inspection of the strength and integrity of the bond-line between steel and carbon materials. To do this, we first conducted a fatigue test and subsequent torsion load tests with increasing loads and eventually, beyond the respective rated load. In this particular case, we detected delamination (layer dissolution) near the outer surface of the steering column. These results were confirmed through repeat testing and a follow up ultrasound.

We then scanned the affected region with the MU2000-D and found further delamination visible under the initial damaged layers; something we had not expected. Without the device, ultrasonic inspection alone would not have captured the additional damage.

From these very detailed images and consequent information, the colleagues in our stress department were able to create 3D CT reconstructions and use the data generated to analyse radial delamination. We have now changed our testing procedures to rely heavily on computed tomography to give us vivid illustrations and assessment of the component or region through the entire fatigue testing programme.

Yxlon MU2000-D CT at Renault Sport Formula One Team in Enstone.

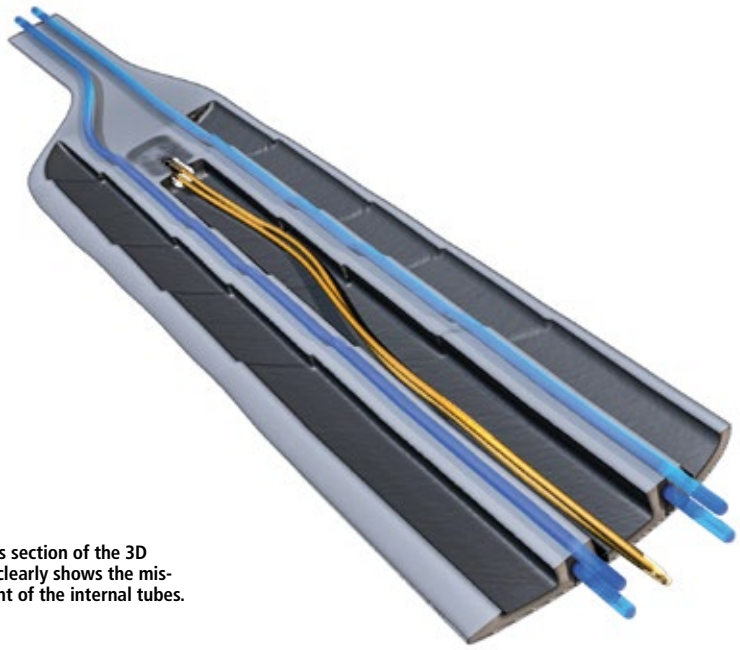
Oil Cross over Pipe

The oil cross over pipe is relatively simple in carbon construction, but boasts an extraordinarily complex shape. This required complexity creates extreme difficulty when trying to detect and recognize internal structural anomalies.

In this example, a foreign body consisting of an adhesive which connects the aluminium to the carbon, created an oil flow restriction in an internal intersection.

We first applied our standard procedure, inserting a borescope into the pipe and assessing its internal features visually. Due to the angle of viewing and unaccounted for light reflection, the glue anomaly was initially deemed acceptable.

Continued on page 10



© Volume Graphics

The cross section of the 3D volume clearly shows the misalignment of the internal tubes.

> *"With the limitless possibilities of X-ray and CT technologies, our non-destructive testing processes have become much faster and more reliable."*

It was not until we took CT scans of the area and modelled the obstruction that we realised the significant impairment it caused in the functionality of the pipe. It not only disrupted oil flow, but also promoted cavitation, reduced the pipe's fatigue life, and could have possibly detached from this position and caused more damage further downstream. Following this experience, we adapted our inspection procedures to help prevent similar mistakes in the future.

Wind Tunnel Pitot Tube – Direct Metal Laser Sintered Material (DMLS)

Our wind tunnel department approached us with a newly developed and more sensitive Pitot tube. The Pitot tube, otherwise known as a static pressure probe, measures the airflow over the front of the vehicle. The wind tunnel allows us to have a constant stream of air for a controlled measure. This helps us identify and design cars with optimal aerodynamics. The Pitot is part of an ongoing development project aimed at using additive manufacturing, or 3D printing techniques, for rapid prototyping out of titanium material. The tube was implemented in the wind tunnel immediately after its production, with only a dimensional check being performed.

The primary test results were an early indication that something wasn't quite right. Time at the beginning of the race season is always tight, and wind tunnel testing is an extremely important part in our preparations so the team needed to figure out right away where the problem was. We scanned the tube with digital X-ray, rendered a cross-sectional view of the component with CT and discovered the source of the malfunction. The internal tubes were misaligned and although it looked fine externally, the internal construction was producing faulty results.

Previously, we would have had to physically section the tube in our materials lab using a time-consuming, destructive process. Instead, we were able to immediately forward the X-ray and CT images on to our supplier and receive a corrected piece within 24 hours, and the new Pitot tube was installed and fully operational in under 36 hours.

Summary of System and Software

The Y.MU2000-D has proven its flexibility and reliability in a plethora of different applications. Its capabilities cover a wide range of manufactured parts in the automotive, aerospace, and many other industries. It is a reliable all-round system, ideal for both single and serial part testing and is implemented in R&D labs worldwide for both academic and production purposes. It produces very good image quality and reliable results even in demanding environments.

The Variofocus tube, integrated into the Renault Formula One system, increases the spectrum of possible test parts by magnifying the variable focal spot from 250 µm at 290 W to 800 µm at 1,600 W to ensure optimal detail recognition in components of all sizes. Additionally, thanks to its power and flexible performance the system is able to penetrate thick materials such as aluminium and Inconel.

The CT function of the MU2000 allows users to easily switch from digital radioscopy (RD) to 2D and 3D computed tomography, providing more detailed information about composition, defects, and internal structures. This combined with the release of the new user-friendlier 3.0 version of VGStudio Max, expands the analysis and visualisation possibilities.

With each new version, Volume Graphics further expands the capabilities of VGStudio Max, their software for the analysis and visualization of industrial CT data. A CT scan of the part is all you need to unlock the enormous power of VGStudio Max, which can carry out a myriad of renderings and analyses directly on the voxel dataset. The software is suitable for almost all types of parts, from plastic or metal cast parts to porous materials, foams, fiber-reinforced composites, or 3D-printed objects. The voxel dataset generated from the CT scan captures every detail of the physical component, making it the ideal basis for conducting a wide variety of material and geometry-related analyses, such as metrology, defect analyses, or simulations.

Ideal for Racing Car Manufacturing

Adrian Talbot can attest to the power of X-ray technology, saying, "With the limitless possibilities of X-ray and CT technologies, our non-destructive testing processes have become much faster and more reliable. This offers huge benefits for us, especially for the testing of vehicle parts and components between races. We also now possess the ability to take detailed pictures of components for further analyses before and after the races and to document future developments. This not only reduces costs, but also allows technical innovations to be implemented and used more quickly."

The technical director of the Renault Sport Formula One team, Nick Chester, adds: "We will be able to significantly increase the quality of all components, both during developmental stages as well as production processes. Structural analyses of various materials, from fibre composites to 3D-printed components, can be performed much more precisely than with our conventional testing methods. Damage analysis and nominal-actual comparisons using CAD data can also be created and evaluated with better efficiency. All of these benefits will positively impact the overall quality and more importantly, safety of our racing vehicles."

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Machine Vision in France

EMVA Report Unveils Market Peculiarities in Europe's Second Largest Industry Nation

In its latest market report 'Machine Vision in France' the European Machine Vision Association identified the market players in France and investigated the characteristics of the French machine vision market.

France is the second largest industry nation in Europe. Unlike its neighbors Italy and Germany, the French economic structure is shaped by large enterprises that also dominate the industrial sectors. SMEs in France are still underrepresented in the sheer number of companies and in terms of their international competitiveness, a fact that is often mentioned as a weakness of the French economy. With two domestic car manufacturers and a number of large tier one suppliers the automotive industry plays an important part in the French economy. Other industries that also play a role are the chemical and pharmaceutical as well as the electronics industry. What stands out compared to other Europe is for one thing the competence in infrastructure and transportation with two major manufacturers of rail infrastructure. Even more important in France are the aerospace and military sectors which are centered in Toulouse and in the greater area of Paris, the so-called Île-de-France. Aside from traditional industrial production agriculture, tourism and the food sector make a countable contribution to the French economy.

Automation Trends in France

In the past, France was not known to be at the European forefront in terms of automation. It seems, however, that this attitude is changing rapidly. Customers become more quality-oriented and, in the context of IoT and Industry 4.0, the need to invest in automation is rising. So are, for instance, large producers in the food sector reported to increase their efforts to further automate. A clear signal was set by the French government in 2015 with the launch of the national project Industry of the Future (Industrie du Futur). Out of this, the Industry of the Future Alliance was created which, according to its own description, is tasked with putting into practice the national Industry of the Future project, "in the framework of the organizational overhaul of the new face of Industry in France." The goal is to "make France a leader in the world's industrial renewal and to propel the entire national industrial fabric right into the heart of the new industrial systems."

> *"In 2018, the French machine vision market is set to grow further on single-digit level."*

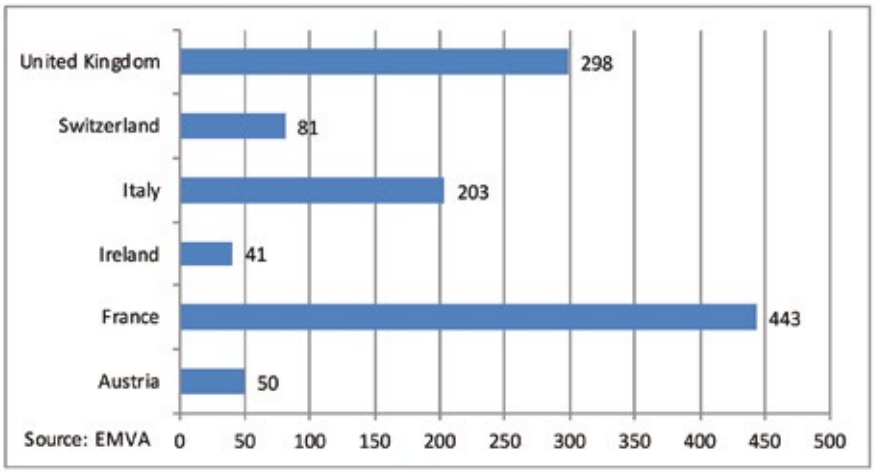
Machine Vision Industry in France

Due to the structure of the French economy machine vision players in France tend to have fewer customers in the segment of medium-sized enterprises. Integrators, many of them acting locally, play a significant role in the industrial application of machine vision in France. Another great asset of the French machine vision market are the highly specialized system solution providers that serve various industries with custom-made vision solutions. These include web inspection systems, vision systems for the automotive industry, railway inspection, food inspection, recycling, ITS, inspection solutions for the pharmaceutical industry and PCB assembly, as well as bottle inspection machines and fruit sorting in agriculture. In fact, practically all of these solution providers are SMEs, and they act quite successfully on international level, making them a role model for the entire economy. They are supplemented by a high single-digit number of system solution specialists for machine vision in robotics and factory automation that tend to have stronger focus on the domestic market. Machine vision competence for the important aerospace and military sectors are largely located in-house in vision departments of these industry´s big enterprises, but they are also served by pure machine vision players that - understandably - are rather secretive.

One characteristic that is often heard when the French machine vision industry is described is that in light of the market size there are not so many relevant machine vision component manufacturers in France. This is only partly true, since a good part of the quite impressive number of 231 machine vision industry players in France that were

identified in the report really are component manufacturers. Only few of them, however, have a size that makes them relevant to appear constantly in the domestic market or even internationally. Therefore, the supply of components in the French machine vision market is dominated by components mainly manufactured abroad and sold by multi-brand distributors, as well as by the direct distribution from international component manufacturers.

Besides factory automation-oriented suppliers of vision technology, a number of companies have established in France to serve various new emerging non-industrial fields; and through good start-up funding schemes France has become a cradle of young enterprises that are active in virtual reality, deep learning, eye tracking and other computer vision disciplines.



France has the highest number of players of all geographic regions that have been investigated by the EMVA Machine Vision report so far.

Machine Vision Research and Education in France

The French state traditionally has a strong influence on the national economic and industrial policy. This is reflected, inter alia, in the support of industrial development, the direct involvement of the state in enterprises (état actionnaire); and to a great extent also in research and development. Thus, the theoretical research landscape of machine vision or computer vision related institutes is extremely rich in France. Many institutes are linked through the National Center for Scientific Research, or CNRS, a public organization under the responsibility of the French Ministry of Education and Research. The CNRS research group ISIS (Information, Signal, Image, Vision) alone counts more than 160 members. Geographically, machine vision education and research have their strongholds in the areas where the technology is most demanded, predominantly in Brittany, the Rhône-Alpes region, and the metropolitan region of Paris.

As far as education is concerned, graduates from the famous French elite schools are rarely found in the French machine vision business, because these students tend to prefer large French company names to start their career. Also, the level of practical orientation and training at universities is not as high as many employers would wish; and - with only a few exceptions - machine vison or computer vision is generally not taught as a major subject. Practical orientation is being granted to a much higher degree by the engineering schools in the country with a dual three-year education. Some of them have specialized faculties in machine vision or related subjects such as machine learning and convolutional neural networks.

Summary and Outlook

Overall, the EMVA report Machine Vision in France has identified 443 players in the French vision industry that are listed by name and website. Out of these, 231 are enterprises active in the machine vision business, 187 in research and education, and 24 players are associations or clusters. This is the highest number of players of all geographic regions that have been investigated by this report format so far.

Technical affinity is by all means a French attitude. In this context it seems to be a French peculiarity to sometimes overdevelop technologies and put the focus on in-house development – even if certain components are not key competence and might as well be available in the world. On the other hand, it is likely that, with the Industry of the Future project led by the government, the French industry will catch up on the topic and increase the necessary investments to raise the level of automation. This will also boost the demand for machine vision technology as an enabler of advanced automation. In addition, still relatively untouched sectors such as parts of the agro-industry seem to be promising in France; and the number of start-ups in purely non-industrial segments constantly rises. Last but not least, French machine vision companies are more and more receiving requests from former customers that once tried the technology and then refrained from it. With increasing liability, lower prices and much easier-to-use machine vision systems, these customers are now coming back. Overall, in 2018, the French machine vision market is set to grow further on single-digit level.

Founded in May 2003 in Barcelona, the European Machine Vision Association currently has well over 100 members representing more than 20 nations. Its aim is to promote the development and use of machine vision technology and to support the interests of its members – machine vision companies, research institutions and national machine vision associations. The main fields of work of EMVA are standardization, statistics and market research, the annual EMVA Business Conference, new conference formats such as the Embedded Vision Europe Conference and the European Machine Vision Forum, and networking events across Europe, as well as European research funding. Non-members can obtain the individual editions of the EMVA Country Report series with all players listed by name and website by contacting info@emva.org. To find out more visit the web site www.emva.org.

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Torsten Wiesinger (left) and Rod Barman (right), Lucid Vision Labs

Five in Five

With Lucid Vision, another camera manufacturer has emerged in the machine vision landscape. Not just ‚another' though – with thorough market knowledge, a clear vision, and technological USPs, Rod Barman (Founder & President) and Torsten Wiesinger (General Manager, EMEA) have the valuable equipment at their disposal that is necessary to be successful in today's challenging market conditions. We asked them how it all came about and what their future plans are.

inspect: Two people as experienced as yourselves – what was the reason for founding another new camera manufacturer (as there are some in the market already…)? What's the "vision" behind Lucid Vision?

Rod Barman: We are seeing a major shift in the industry driven by many emerging technologies such as IIoT, AI, Deep Learning, Embedded Vision etc. It is an exciting time and opportunity to be part of this new era of industrial production where machine vision will play a central role in smart manufacturing, but also in many new applications outside of the factory. We are fortunate to have a highly experienced team who shares a common vision and a true passion for the machine vision industry. We describe our vision simply as "five in five" which means that we aim to be one of the top five camera suppliers within five years and become an established vendor on a global scale. But ultimately, we would like our customers to know us for innovative, high quality products that provide real value to them, and in the long run to trust us as a competent partner for Industry 4.0 imaging technology.

inspect: What exactly does "Lucid" in your company name stand for?

Rod Barman: Lucid means that we are a clear and transparent company, easy to work with and precise in the things we do, bringing new light into the machine vision industry. Lucid has of course also something to do with our products and means "seeing clearly." We want to take digital imaging to the next level by designing cameras that push the boundaries of imaging performance and introduce new sensing technologies such as polarization, multispectral etc. that help to see more clearly.

inspect: Looking at your target group: who are your potential customers, and which are the industries and applications you are targeting?

Torsten Wiesinger: We are targeting a broad range of customers in factory automation, intelligent traffic systems, medical and scientific, agriculture, logistics etc. who need flexibility and are looking for more unique features than what's currently being offered in standard products. Our goal is to leverage unique sensor technologies to address different market needs. We want to introduce technologies that will help transform our customer's vision system and realize the tremendous potential of Industry 4.0.

inspect: In terms of distribution, will you be looking at the Canadian/North American market first, or are you planning to go global right away?

Torsten Wiesinger: Going global has been our mission from the beginning. We have four Sales regions at this point: North America, EMEA, China and APAC and our

Sales team has many years of industry experience. By the way, we are actively looking to hire new employees for our teams in Sales, Engineering and Customer Support.

inspect: Lucid's technology is mainly based on two interface standards: GigE-Vision (hardware) und GenICam (software). What was your thought when choosing both, and are you looking to support additional interfaces in the future?

Rod Barman: We will continue to follow the path of Gigabit Ethernet and are looking at other Base-T networking interfaces. Vision applications where devices are closely packed together can fall victim to different levels of interference. Unlike other interfaces, such as USB 3.1, which can respond to interference or interfere with services operating in the 2.4 GHz range, Ethernet operates at a much lower frequency making GigE Vision cameras and Ethernet components unlikely to respond to interference or interfere with wireless devices. Ethernet also has the benefit of longer cable lengths, power-over-Ethernet and low emissions with shielded cables.

GenICam has helped the industry standardize camera features and create a unified API for 2D and 3D imaging. This allows customers to design hardware agnostic software applications and allow them to choose cameras that best fit their needs. The standard is continuously being updated to meet the evolving application needs of the machine vision industry. Supporting GenICam with our cameras ensures that we are providing the most cutting-edge technology to our customers.

inspect: Does your product portfolio demonstrate particularly unique selling propositions apart from the before-mentioned interfaces?

Torsten Wiesinger: As of today, we have the world's smallest GigE PoE camera in the market called Phoenix, measuring only 24 x 24 mm. In addition to its micro-compact size, the Phoenix camera offers a transformable form factor allowing it to be used in various orientations e.g. 90-degree or 180-degree. Featuring NF-mount and lens options, it provides an even smaller footprint compared to C-mount lenses, as well as an ix Industrial Ethernet connector which takes 70 % less space than RJ45 sockets.

In addition to the hardware technologies in our portfolio, another big differentiator will be the software. Here we will have several exciting features on our roadmap which will support our strategy for Industry 4.0. One other thing to mention here is that as a new company, we do not have the burden of supporting legacy products which will open up new opportunities for us to design products that leverage leading-edge technology and to create the most value for our customers.

inspect: One maybe a little indiscrete question (due to the vicinity to Point Grey in Vancouver): Where is the Lucid team recruited from? Are there rather young potentials or experienced staff? (Bearing in mind, as a comparison, that in Germany we are suffering from skills shortage).

Rod Barman: Our staff is highly experienced, otherwise we wouldn't have been able to build and demonstrate products within a year. We have employees from different backgrounds including former Point Grey, Sony, IDS Imaging and other technology companies with accumulated decades of combined experience inside the machine vision industry. As for myself, I was the original Founder, President and VP of Engineering at Point Grey for 19 years and directed Point Grey's year-over-year growth into a worldwide leader of industrial cameras. Torsten brings over 15 years of experience from the machine vision industry and as many of your readers may know, he has been the CEO at IDS Imaging Development Systems for six years and more recently the Sales Director of MVTec Software.

With our combined inhouse experience, I wouldn't consider ourselves a traditional start-up company. Yes, we are still a young company so that we can be faster and more flexible than the market leaders, but we are bringing the experience of a mature company to keep up with them in terms of stability, quality, product availability and commitment.

inspect: It was nearly a year ago that the company was founded, and you have already launched two camera series, plus an own SDK. How was this made possible so quickly?

Torsten Wiesinger: As mentioned before we hired very experienced people who all share the same vision. Our technology and IP have been developed at Lucid from the ground up by our engineers who are passionate about building unique and innovative products to help customers solve their design challenges. It's also important not to start alone of course. In every discipline you need to have good and experienced people.

"We want to introduce technologies that will help to realize the tremendous potential of Industry 4.0."

inspect: Which role does embedded vision play for Lucid?

Rod Barman: We see the current embedded vision trend as one step towards the ultimate goal of seamlessly distributed vision processing both at the edge and in the cloud. We have more plans around embedded vision and Industry 4.0 that are different from our competitors. But that will not be unveiled at the moment.

inspect: Looking at 2018's upcoming industry highlights, such as The Vision Show in April and Vision fair in November – what can we expect from Lucid in the near future?

Torsten Wiesinger: Our initial focus is to expand our product pipeline with a range of resolutions and frame rates and offer unique camera features and capabilities. But of course, we're already working on some exciting, new products that will leverage unique sensor technologies to address different market needs. Rest assured, there will be some ground-breaking technologies unveiled at the show floor.

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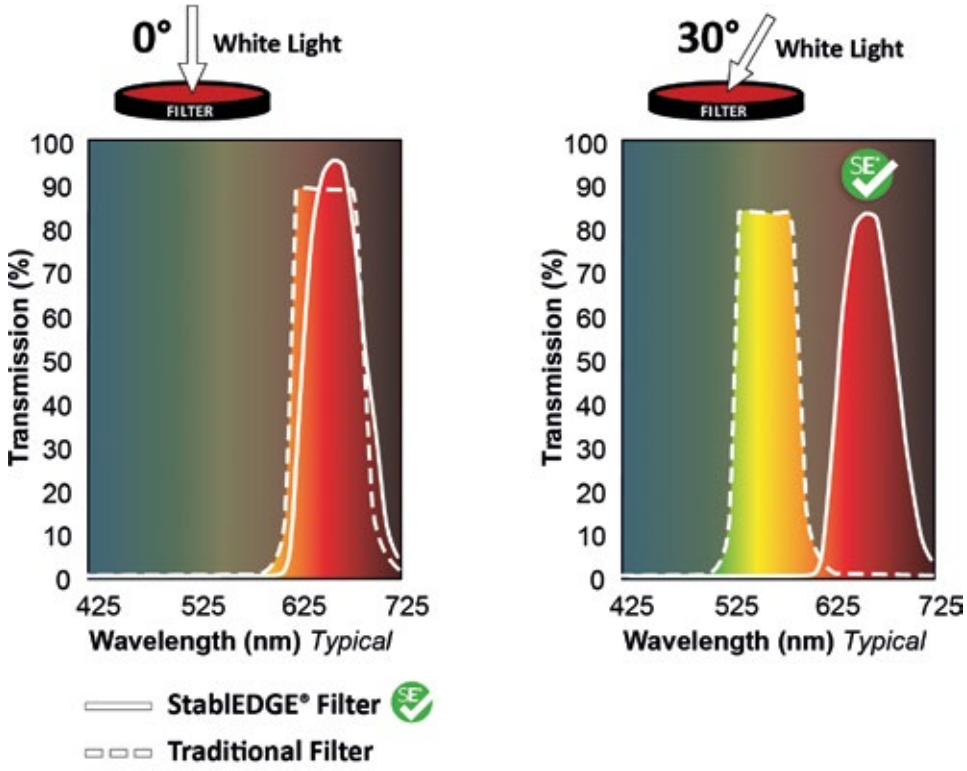

Not All Filters Are Alike

Key Features to Look for When Choosing Filters for Machine Vision Systems

Optical filters are important components for machine vision applications. However, a vision filter is not just a machine vision filter – there are key features to look for in order to find the appropriate one.

Filters for machine vision systems are used to maximize contrast, improve color, enhance subject recognition and control the light that is reflected from the object being inspected. Choosing a quality filter for a machine vision system involves knowledge of a few important characteristics.

Superior Wavelength Control

Short-shifting occurs when the angle of light passing through a traditional filter increases. This is most commonly seen when the filter is placed in front of a lens with a focal length of 12 mm or less (lenses with greater than 50 (+/-25) degree angular fields of view. This accounts for almost 60 % of all lenses used today—a number that continues to grow as the demand for space forces inspection footprints to shrink. Compared to traditional coated interference filters, advanced designs are less sensitive to angular shifting, are more rugged and offer superior lower wavelength blocking – such as MidOpt's Stabledge technology that is available across a full range of products.

Unmatched Passband Performance

Some filters are marketed as having a high and flat transmission profile to provide more even illumination. This shape can actually lead to an undesirable loss in contrast. In these cases, the weaker tail ends of the LED spectral output curve dictate the fit of the bandpass design, allowing an overwhelming amount of ambient light to pass through in these regions. To ensure your machine vision bandpass filter is most effective when used in monochrome applications, the position, height and width of the passband should emulate the bell-shaped spectral output curve of the LED illumination being used. All of the company's bandpass filters are designed with this principle in mind.

High-Transmission Anti-Reflection Coating

When a ray of light passes through a glass surface, a portion of the light is reflected, resulting in a 4 % transmission loss per surface. This means only 92 % of the light actually passes through the glass, and the rest is reflected from the surface, known as reflection loss. MidOpt uses anti-reflection coating on all filter designs, reducing surface reflection to less than 1 %. This improves the efficiency of the vision system by increasing transmission, enhancing contrast and eliminating ghost images.

Optimal Performance and Repeatability

With improvements in sensor technology and camera resolution, there is an increased demand for filters that are free of distortion. Double-side polishing the glass substrate of all bandpass filters helps to achieve optimal flatness. Surface quality is also important, so the images are free of imperfections. Exceeding the industry surface quality inspection standard with a 40/20 scratch/dig ratio and offering a 10/5 scratch/dig ratio in cases where the filter is placed in front of the sensor, where imperfections are most pronounced, MidOpt offers high-quality products. To ensure every filter upholds the highest standards, state-of-the-art spectrophotometer technology is used to test filter

Continued on page 18

MIDOPT
MIDWEST OPTICAL SYSTEMS, INC.

INNOVATIVE FILTER DESIGNS
for Industrial Imaging

Optical Performance: high transmission and superior out-of-band blocking for maximum contrast

StablEDGE® Technology: superior wavelength control at any angle or lens field of view

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Exceptional Quality: 100% tested and inspected to ensure surface quality exceeds industry standard

Product Availability: same-day shipping on over 3,000 mounted and unmounted filters

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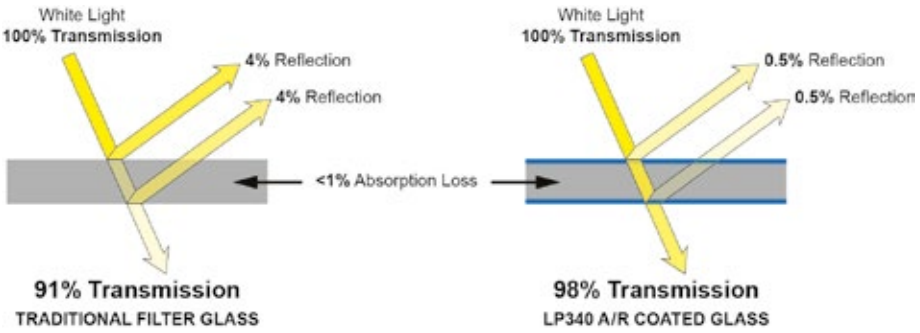
> *With improvements in sensor technology and camera resolution, there is an increased demand for filters that are free of distortion."*



A filter passband that is too broad for the LED spectral output curve results in overwhelming ambient light. For best results, a filter passband should mimic the emission of the LED spectral output curve.

performance. The company also recently introduced a cutting-edge Robotic Assembly & Inspection System to ensure quality and repeatability by limiting the possibility of human error in the manufacturing and inspection processes.

Consistent Quality Inspection

A Robotic Inspection Station guarantees consistency and uniformity when inspecting scratches, digs and other cosmetic defects. A greater variety of inspection lighting is utilized, increased magnification and additional inspection steps are employed, and the variability of individual perception is removed from the inspection equation. This results in pristine optical surfaces and superior image quality.

Torque Controlled Mounting

When assembling optically flat, precision polished filters into tightly screwed down filter mounts, interferometric measurements reveal drastic deformations caused by the stress of assembly. The resulting optical distortion can significantly impact image quality. The company´s Robotic Assembly Station allows each filter to be gently and securely held in the filter mount by the retaining ring. After ideal torque is applied, controlled amounts of thread-locking compound are dispensed to prevent the retaining ring from shifting.

Manufacturing Services

All MidOpt filters can be precision cut to exact specifications and system requirements – in high volumes and with short lead times. Custom shapes and sizing options up to 165 mm² are possible for most filters.

- Custom sizing: An automatic edging system is used for fast, precise diameter sizing to simplify the fitting for any mount.
- Beveling: Beveling smooths edges and/or corners for chip-free installations.
- Precision dicing: Precision dicing is ideal for achieving superior edge quality and tighter tolerances in square or rectilinear filters.
- Laser cutting: Acrylic filters, polarizers and protection windows can be custom laser cut up to 900 mm².
- Laser engraving: Custom engraving options for branding and part numbers are available for OEM applications.
- 3D printing: 3D printing technology allows the quick creation of functional prototypes and custom mounting solutions.

MidOpt offers a large variety and stock of mounted filters.

Convenient Mounting Solutions

Same-day shipping and stocks over 20,000 mounted filters, ranging in size from M13.25 to M105 are available, as well as a variety of other mounting solutions, including options for applications without filter threads, custom mounting solutions and the MidOpt exclusive 25.4 C-Mount filter that threads into all C-mount cameras behind the lens.

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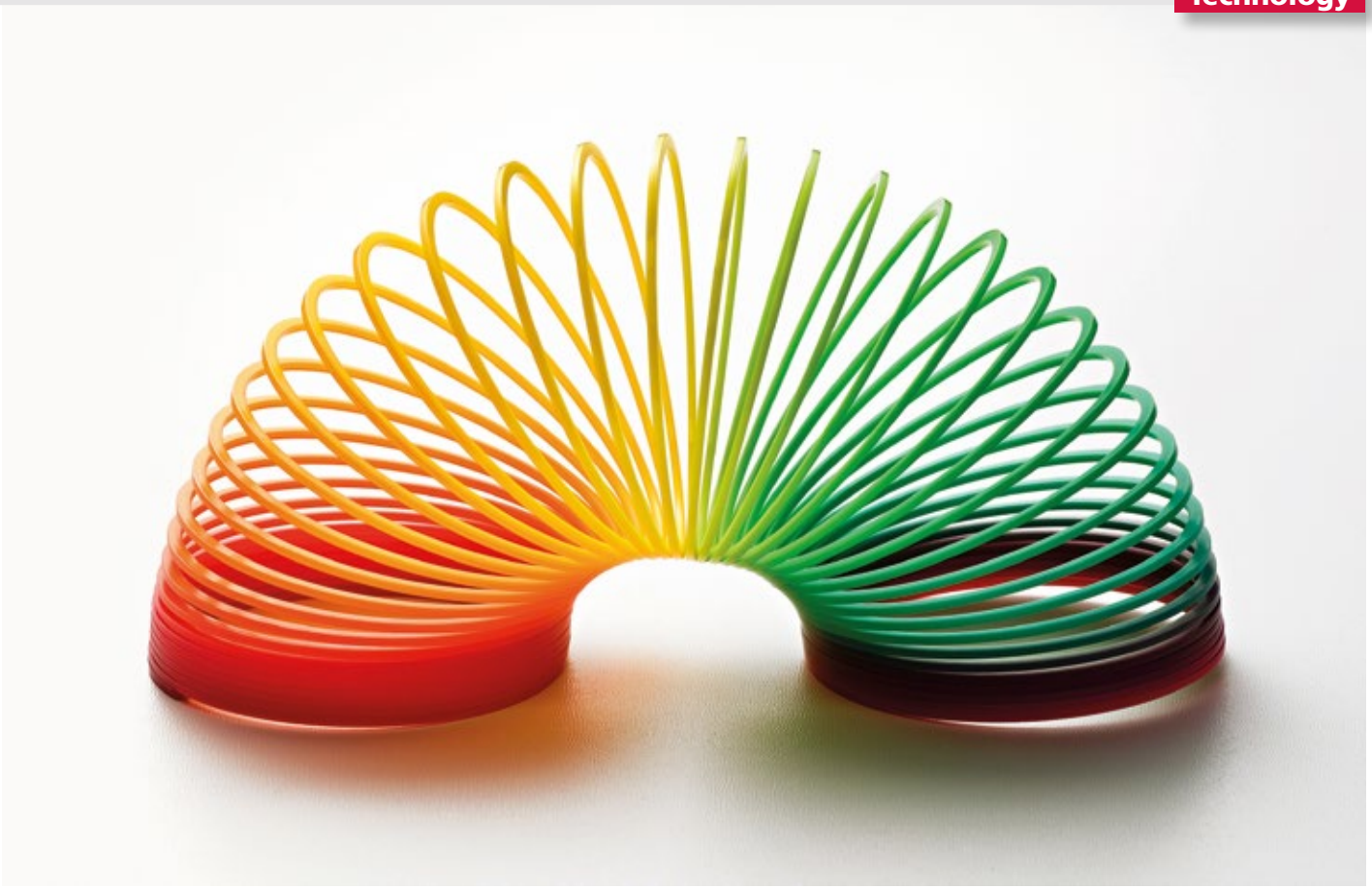


Telecentricity Meets Flexibility

Liquid Lens Telecentric Lenses Are a Combination of Two Technologies that Taps New Potentials

The introduction of liquid lens telecentric lenses saves time and money, and applications that could hardly be realized before are now within reach. This article informs about telecentric and liquid lenses and highlights the benefits of a combination of both.

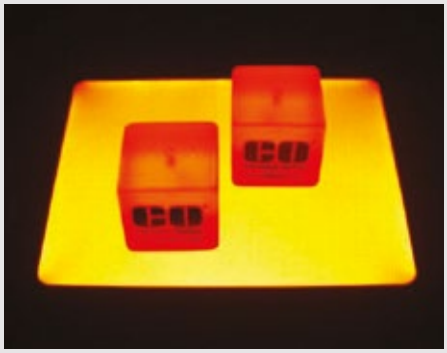
As technology advances rapidly, new products, developments and technologies are introduced to the market in order to achieve better results in all kinds of applications and regions. One of these new developments, and certainly an advancement for machine vision and telecentric applications, is the combination of telecentric lenses and liquid lenses. Telecentric lenses are in use whenever a high precision measurement is required in machine vision and industrial environments. However, the utilization of telecentric lenses is typically limited to one object distance. In order to adapt to other object distances the lenses have to be manually focused or a complicated mechanical focusing mechanism has to be realised. If there are objects under inspection with different heights or in different object distances, using telecentric lenses is difficult and involves time-consuming developments.

Telecentric Lenses

Telecentricity means the maintenance of the imaging lens magnification independent of the distance between object and lens. Telecentricity is achieved through the position of the iris in the telecentric lens design. There are three types of telecentricity: object space telecentricity, image space telecentricity and double sided telecentricity. For object space telecentric lenses the entrance pupil has to be at infinity, meaning the chief rays in object space are parallel to the optical axis and the magnification will not change even if the object distance changes. The front lens of this telecentric lens design has to be as big as the object under inspection in order to view the whole object. Object space telecentric lenses are a must if you need precise measurements in your imaging application. For image space telecentric lenses the exit pupil is at infinity, meaning the chief rays in image space are parallel to the optical axis. The image distance can be changed without changing the magnification which means you do not have to worry about the exact sensor position in your camera and the illumination on the sensor is more even. Double sided telecentric lenses offer fixed magnification in object and image space and therefore combine the benefits of object and image

> *“Combining telecentric lens and liquid lens technology brings numerous new possibilities.”*

Continued on page 20

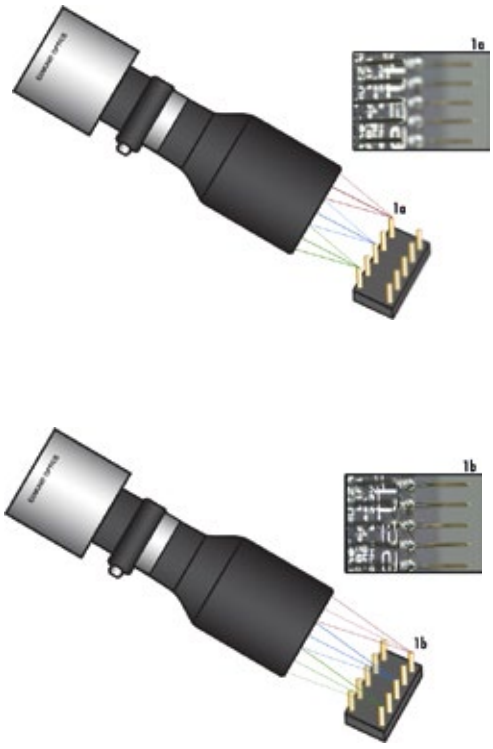


Setup

Image taken with fixed focal length lens (entocentric lens)

Image taken with telecentric lens

Illustration of telecentricity: The image taken with the fixed focal length lens clearly shows perspective error and the objects in different working distances have different sizes. The image taken with the telecentric lens has no perspective error and the objects appear to have the same size despite the different distances.



Inspection of objects at different distances using a liquid lens telecentric lens. The telecentric lens provides an image without parallax error, the liquid lens enables focusing to the two different sets of pins.

space telecentricity. It is important to note that telecentricity does not imply unlimited depth of field. Telecentric lenses also have their specific depth of field range according to the f/# of the lens. Although the magnification and telecentricity is maintained until infinity, the image becomes blurry outside of the depth of field range.

Telecentric Lens Versus Conventional Lens

For conventional entocentric lenses the magnification changes with the distance between object and lens. The resulting image shows perspective or parallax error and is similar to the image of our eyes. The objects closer to our eyes appear bigger than objects that are further away, even if the objects have the exact same size. If you measure the size of objects at different distances in images taken with a conventional lens with parallax error, the measurement will not result in the exact object size. In order to measure the size of an object independent from the working distance a telecentric lens is required.

Liquid Lenses

Liquid lenses consist of a housing filled with an optical fluid and sealed off with a membrane. The lenses can be electrically focused on different working distances and therefore provide a high versatility in different applications. If an electrical current is applied to the lens, it changes its shape. This leads to a change of optical power, focal length and working distance. Electrically operated liquid lenses can be focused to different objects in different working distances within milliseconds, providing high speed, repeatability and reliability in challenging industrial environments and therefore exceeding mechanical focusing mechanisms. Liquid lenses feature a very long lifetime of millions of cycles and can be used self-contained or integrated in optical assemblies or imaging lenses.

Integration of Liquid Lenses

As integration of liquid lenses in bigger optical assemblies is not always an easy task, manufacturers of machine vision imaging lenses often provide lenses where the liquid lens is already integrated in the optical design. This option saves the user a lot of development time and eliminates the need to consider optical parameters in order to find the right liquid lens and liquid lens position for the specific application. Liquid lenses are small and lightweight. The required space for integration is small as is the effect on size and weight of the industrial imaging lenses. Big mechanical focusing systems in space restricted industrial applications belong to the past. The electrical cable for changing the current of the lens is also small and can therefore be easily integrated in the assembly providing good accessibility to the liquid lens. So far liquid lenses were mainly integrated into C- and S-Mount fixed focal length lenses, but why not use a different approach and integrate them in telecentric lenses as well?

Combination of Telecentricity and Liquid Lens Technology

Integrating liquid lenses into telecentric lenses brings two main advantages:

- The telecentric lens provides accurate measurement in challenging applications without parallax or perspective error.
- The liquid lens provides very quick and smooth focusing on different objects and working distances.

By integrating the liquid lens, the high image quality is not changed and the telecentric lens can be used in a whole working distance range. This fact is for example very useful in inspection applications with objects at different distances under inspection. Refocusing to the new distance only takes a few milliseconds, the telecentricity and therefore the magnification is maintained. For telecentric measurement lenses especially the location of the entrance pupil is essential for telecentricity and should not be changed while refocusing with the liquid lens, meaning it is even more difficult to integrate liquid lenses into telecentric lenses than into fixed focal length lenses. Keeping this in mind users should consider to benefit from the optical design experience of imaging lens manufacturers and integrate complete assemblies with already integrated liquid lens in given applications. Liquid lens telecentric lenses are always only object space telecentric lenses, as the integration of the liquid lens either changes the entrance or the exit pupil location and draws it away from infinity. In order to maintain telecentricity in object space, the image space telecentricity is sacrificed.

New Possibilities

The combination of telecentric lens and liquid lens technology brings new possibilities to all users who have to develop machine vision applications with high precision measurements, for example in industrial environments. The addition of the liquid lens brings unknown flexibility to telecentric applications and allows for quick focusing to different working distances while maintaining full telecentricity and highest image quality. Due to the low focusing time, the throughput of items under inspection can be increased, time and money can be saved. The size and installation space of the telecentric lens is only marginally increased by adding the liquid lens, so liquid lens telecentric lenses can easily be integrated into existing applications where quick depth of field adjustment is required. The use of liquid lens telecentric lenses simplifies not only inspection applications, but also gauging and precise placement, and it opens a wide range of possibilities for future applications and developments in all kinds of areas.

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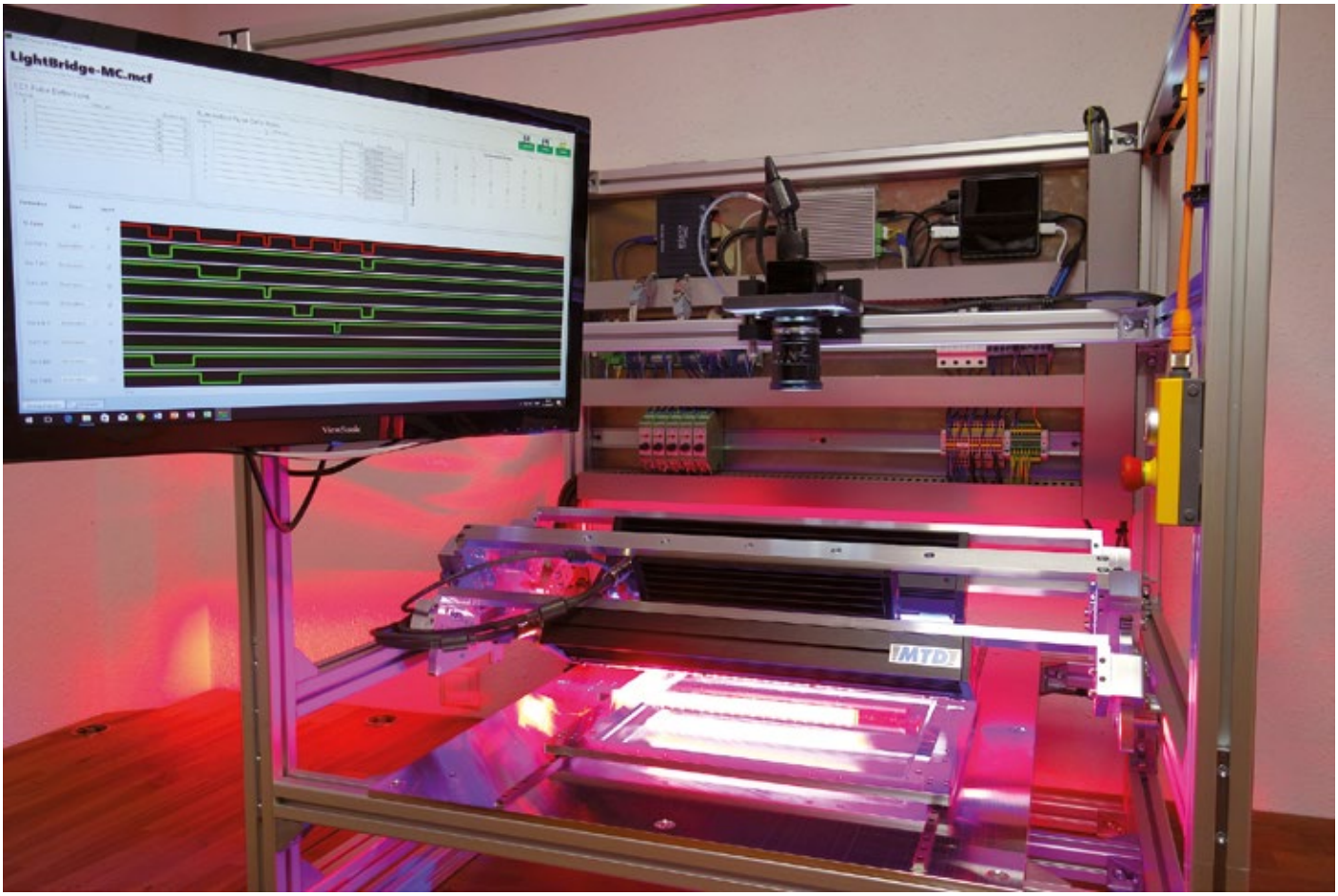

Multichannel Made Easy

More Potential with a FPGA Programmed Application

Realizing image processing systems with different illumination situations is often bound up with high expenditure. A ready-to-go, compact and portable image processing system uses a single monochrome line scan camera and acquires images with different illuminations as separate events in a single pass.

The technology can be readily expanded to several cameras to increase inspection width. Especially unique to this solution are interchangeable standard components and preconfigured, easily parametrized software. Complex multichannel applications such as radiometric stereo (shape from shading) and multispectral imaging can thus be realized quickly and cost effectively.

Fast and User-Friendly

The MultiChannel2Go processing system from MSTVision enables the multichannel image capture of an object with up to eight different illumination types, i.e., from different angles or with different wavelength, in only one pass. Only standardized components without special electronics are used in this system. Comprehensive configuration possibilities enable the realization of diverse applications. Customers can implement their own applications quickly and without in-depth expertise. However, if they have no appropriate (testing) installations at their disposal, they first have to establish a suitable one. The necessary know-how and the effort such a task entails can represent a significant hurdle for many customers. The image system was developed for just such cases: It simplifies things for users. The system consists of standard hardware such as up to eight triggerable line lights, a line scan camera with easy cabling, as well as a moveable linear axis with a transparent table. The lighting construction is flexibly interchangeable and can consist, for example, of a blue and a UV incident light as well as a white transmitted light with two oblique radiating line lights. Any light sources and controllers

Programmable external frame grabber (center) and Intel NUC Mini PC (right)

> *“The combination of different lighting with one or several line scan cameras and the programmable frame grabber reduces complexity and overall system costs.”*

that can be square wave signal triggered can be installed. With the installed mechanics, all lights are already in the correct position. A user-friendly camera mount stands ready for precise camera alignment. The system exploits the installed components’ limits, using exact timing of lighting situations, thus achieving very short line scan camera exposure times.

No Traditional PC

Instead of a traditional PC with an integrated image acquisition board (frame grabber), one possible system configuration uses the LightBridge 2 external frame grabber from Silicon Software with a programmable FPGA (Field-Programmable Gate Array) processor for image acquisition and preprocessing as well as a small Intel NUC (Next Unit of Computing) mini PC directly at the image source. The NUC-PC is a small full-fledged PC that takes over final image processing and analysis all the way through to image output. The FPGA on the frame grabber allows synchronous triggering of the illumination and the camera as well as sorting of the acquired image data in real time, markedly reducing the NUC PC’s CPU load. In place of the NUC-PC, an optional industrial PC can be connected to the physically separated external frame grabber with long Thunderbolt optical fiber cables, making the system especially well-suited for installation in manufacturing environments.

Image Processing System for Versatile Use

Since the upper section of the system – consisting of illumination, camera, NUC PC and the external frame grabber – is detachable, it can be easily and flexibly integrated into other image processing systems. “Numerous architectures are conceivable, like the use of one or more infrared line scan cameras (for example multispectral imaging with InGaAs cameras) for imaging various wavelengths in multispectral applications, but also for optical setups based on transmitted light, or the synchronous use of several frame grabbers to raise the system’s bandwidth,” explains Michael Stelzl, Managing Director of MSTVision and developer of the Multichannel2Go system. “Currently, monochrome line scan cameras for Camera Link are supported, further interfaces are to come.”

The entire system is easy to transport and use and does not need major outlay for modifications. Users are able to carry out evaluations in little time and to use hardware components of their choice without building complex systems or relying on individual manufacturers. Depending on the camera sensor, a large variety of wavelengths can be used in illumination. Users can test this in advance with the flexible system. Moreover, they have the opportunity to rent a system that is already modified for their usual applications for a limited period of time, or to purchase it outright for long-term operation in their own testing laboratory. Thus, they can generate sound feasibility studies for their own customers without modifications, including high-quality image material.

Graphically Programmed Hardware Applet

For image and signal control of the camera(s) and illumination(s), MSTVision developed a hardware applet for multichannel applications using the VisualApplets development environment. Building

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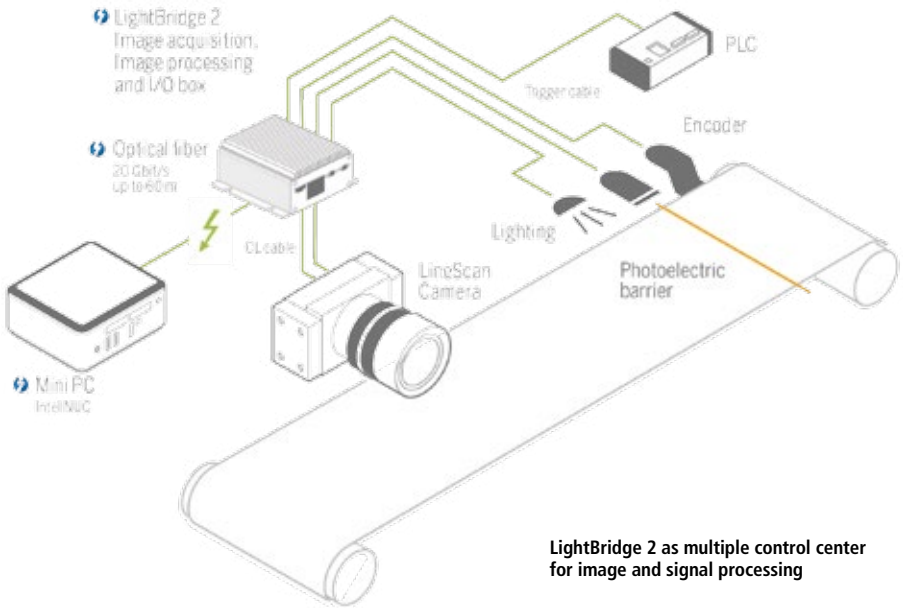

LightBridge 2 as multiple control center for image and signal processing

upon an existing image acquisition design for Camera Link cameras, the applet was created in a short time using the graphical user interface and ported onto the external frame grabber's FPGA. Using the applet, timing and illumination duration as well as the camera's triggering and exposure time synchronized thereto are precisely determined. If, for example, smartphone surfaces are analyzed for various defects such as bubbles, scratches or inclusions, individual defects can be detected using an appropriate illumination situation. The multichannel applet assigns the recorded lines for each lighting situation to a single image channel without loading the CPU. Since the individual pixels of all the image channels are acquired exactly in sync, no algorithms are necessary to correct the position of individual images.

The applet is preconfigured ready-to-use and parameterizable on an easy-to-operate software surface, allowing users to flexibly modify the timing for their own applications.

LightBridge 2 external frame grabber with Thunderbolt cable connections

For easy setting control, the expected signal timing at the outputs is visualized. To integrate the applet into the customer's own software environment, the preprogrammed SDK (Software Development Kit) sample code is provided. Interfaces exist for all widely-used image processing libraries. For further camera interfaces, the applet can be ported onto other hardware platforms.

Different wavelengths can be used with this image processing system; different angles, time delays, and light intensities can be installed, and multispectral imaging or radiometric stereo (shape from shading) with up to 200 kHz at very high resolution can be realized. As a result, a wide variety of applications can be implemented ranging from 3D, sorting, UV and surface inspection to thermography. Even the examination of band material of up to 5 m width can be carried out easily as the system can be expanded to the necessary number of cameras operating in a time-synchronized manner. The system can be implemented in industrial environments and many other fields.

Flexible and High-Performing with Reduced System Costs

The combination of different lighting with one or several line scan cameras and the programmable frame grabber reduces complexity and overall system costs. Hardware is extremely reduced, freely selectable and interchangeable. The optionally realizable physical separation of image acquisition using the external frame grabber on the one hand, and the image evaluation using the host PC on the other hand using their connection via long optical fiber cables is a further plus. "Due to the standard components, this immediately implementable image processing system is markedly more economical overall and available long-term without being bound to individual manufacturers. It can be evaluated in one's own test environments and be modified with little effort on both the hard- and software-side without sacrificing performance," Stelzl emphasizes.

As a result, migration to multichannel is very simple, since hardly any alterations to the hardware platform or the software are needed. Complex software is omitted entirely. "The entire system achieves its high performance in data bandwidth, speed, and precision for signal control and image processing by using the frame grabber and fast, easy FPGA programming via VisualApplets. Since LightBridge 2 functions as an intelligent control center in this application case, a very compact PC could be used," explaines Stelzl. "Multichannel is the easiest path to line scan camera applications with multiplexed illumination situations." For the future, it is planned to port the multichannel system and applet onto further camera interfaces such as CoaXPress and newer, more powerful frame grabber series to even more efficiently control applications such as sorting with outlet nozzles.

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App Your Sensor

Customized, App-Based Vision Solutions

Apps turn smartphones into intelligent assistants with a wide range of tasks. They can also be used to improve and simplify image processing. This turns cameras and sensors into customized vision sensors.

In a typical vision application, camera images are only means to an end. The large amount of image data can be transferred from the camera to a PC for evaluation, but only the subsequent image processing generates application-relevant information from the images. On the other hand, „smart" devices evaluate the states or characteristics of their environment themselves and transmit only a few relevant result data to PCs or process controllers. Traditional vision sensors, such as barcode readers for example, mostly provide only a few predefined tasks and their functionality cannot usually be extended. In view of the current reorientation towards the Internet of Things (IoT) in many markets, there is a rising interest in versatile, autonomous image processing devices.

New Device Generation

A new generation of vision app-based cameras and sensors, IDS NXT, process image information completely independently to final results or to support a PC application with preprocessed data. With the app-based approach, vision tasks can be set up and changed quickly and easily. This eliminates the need to hold several vision sensors in stock for different application types.

The first member of this device family is the NXT vegas sensor. It autonomously reports application-relevant events via its GPIOs. Continuous polling or sending commands is therefore not necessary. For data exchange, the sensor is equipped with generic interfaces. The RS-232 interface can be configured according to individual requirements. An app determines which data are transferred and defines the way to interpret them. The sensor communicates with any machine controller that also uses this interface. Available gateways allow even systems with alternative protocols, such as CAN-Bus, Modbus-RTU, Profibus, KNX, or Profinet, to be addressed.

The Restful (Representational State Transfer) web service provides a TCP/IP communication to configure all device parameters including the apps. It works both via HTTP protocol and the secured HTTPS variant using standard methods such as Get, Post, Put, Patch, etc. Due to the wide distribution of the Rest infrastructure, the sensor device is platform-independent and can be used in a wide variety of applications.

> *„In many markets, there is a rising interest in versatile, autonomous image processing devices."*

The app-based system makes the IDS NXT vegas as versatile as a smartphone. With a light-sensitive 1.3 MP CMOS sensor, an integrated liquid lens, LED illumination and a ToF sensor (Time of Flight) for distance measurement, it is fully equipped for many different image processing tasks. It can neither be classified as a standard industrial camera nor as a highly specialized smart camera or a traditional vision sensor. It is suitable for applications that require highly versatile devices. The board-level option is also interesting for OEM equipment manufacturers. As a complete embedded vision

component, it simplifies integrated design into custom device hardware and software.

App-Based Image Processing

The unique feature of the IDS NXT device generation is that new functions can be installed as easily as apps on a smartphone. The foundation is the plug-in-capable device firmware. In addition to predefined standard tasks, individual tasks can be created with the help of an app development kit. More complex tasks are divided into several apps: vision apps process the image data to generate results; the device communication and data transmission is handled by another app. The inputs and outputs of the apps are linked with each other. This results in a modular system of reusable app building components.

Vision apps can be flexibly programmed in C++. App developers get useful support from the extensive IDS NXT libraries. This allows them to concentrate fully on the actual task of the vision app: image processing. The device firmware is delivered with a pre-installed Halcon Embedded Runtime License. The integration of the Halcon image processing takes place as usual via the C++ interface or through complete scripts using the HDevEngine. The latter guarantees that image processing can be made and tested completely platform-independently on a desktop PC with the Halcon development environment (HDevelop) before it is used in a vision app. The transition from a Halcon script to a complete app-based image processing solution takes just a few steps. Ready-made vision apps are installed and activated via the IDS NXT Cockpit. During the development process, the build tools also support remote debugging of the coded vision apps. With optional manufacturer-specific SSL key pairs (private/public key) in custom vision apps and the IDS NXT firmware, their execution can be restricted to protect your „own expertise“ against misuse.

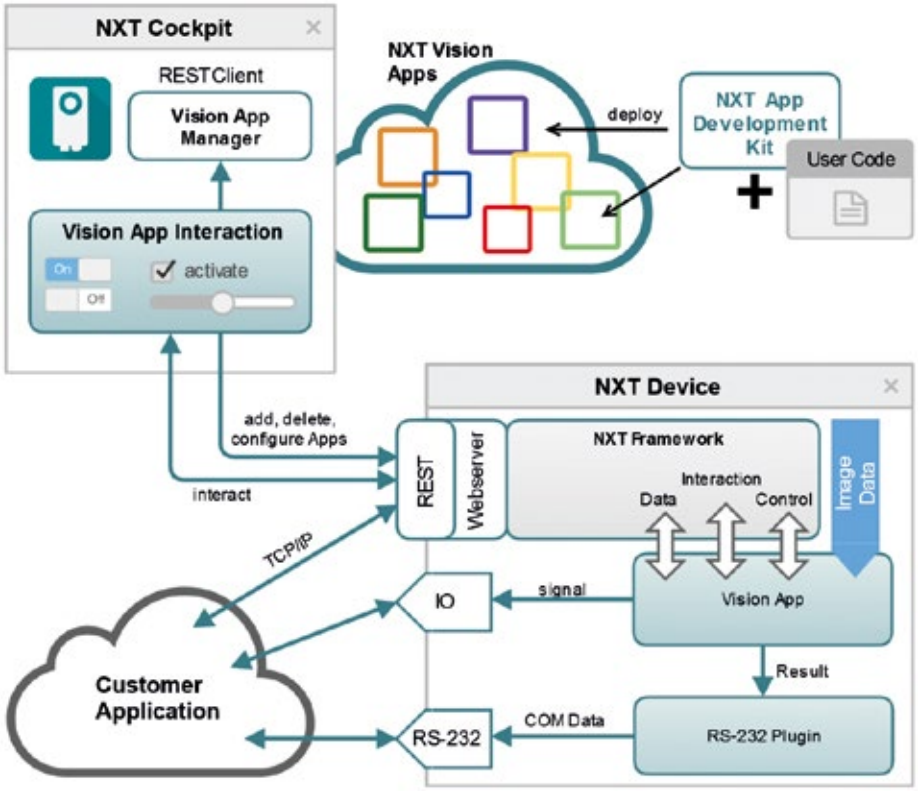
Interaction elements from the vision app library automatically connect image processing to the outside world. Special C++ classes provide actions, configuration parameters, results and data sources. In addition to their according callback functions within the app source code, an interaction interface is provided via the main Restful web service. This enables Rest clients to configure any previously unknown app without being updated. In addition, the cockpit dynamically generates a complete GUI (Graphical User Interface) for each app, making it a universal configuration tool. Therefore, it is not necessary to program your own customized client application.

Free and Unrestricted

With the vegas sensor, IDS Imaging Development Systems launches a new generation of devices that handle image processing tasks autonomously and support a PC application with pre- processed data. However, the freely programmable platform is not restricted to specific tasks. The possibility to install any vision apps offers universal possibilities in numerous fields of application. For example, in optical quality assurance, as an analytical instrument in medical technology, for monitoring tasks by facial recognition or vehicle and person counting. With the HTTP-based Restful web service, the sensor can also be used in industrial PLC environments to support the expansion of industry 4.0 and by using various RS-232 gateways, it can find many more communication partners.

With versatile, autonomously operating devices based on the IDS NXT concept, the company now also offers solutions for digital image processing.

The embedded vision system IDS NXT vegas with IP65-protected housing is also available as board level option.



With the App-based concept, IDS NXT cameras and sensors can be easily extended and adapted to very different applications.

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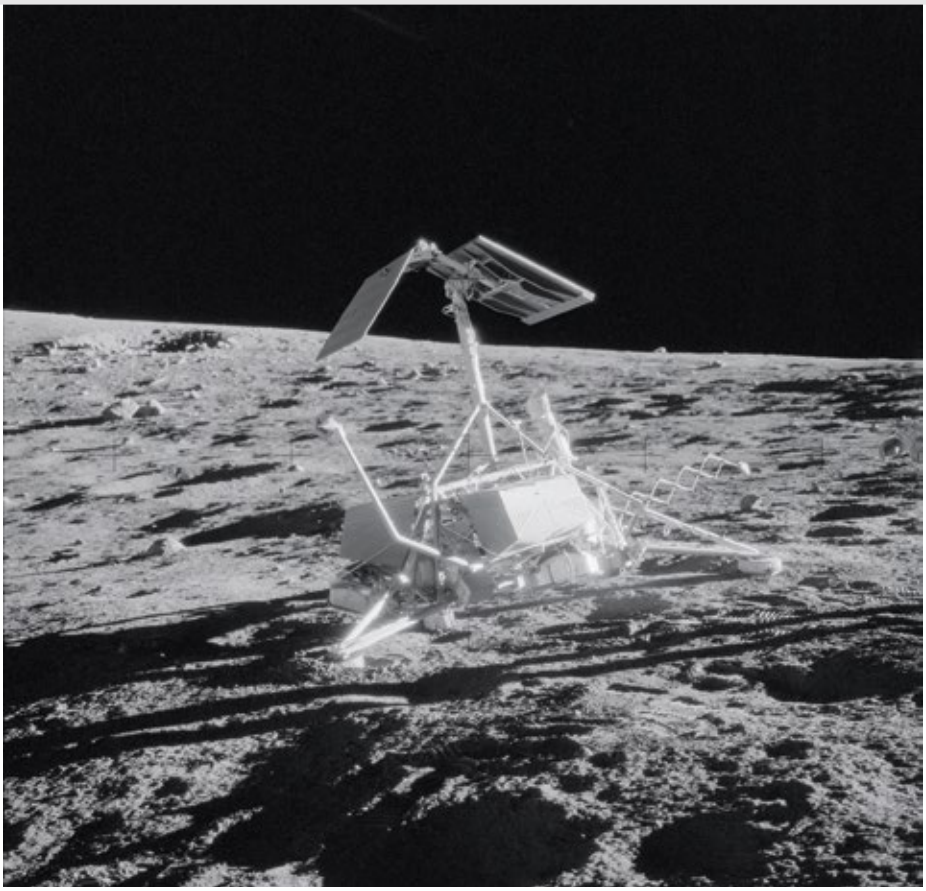


In order to create an archive, film images and data from the Surveyor moon landers stored since the 1960s needed to be digitized. It was a challenge to find an OCR solution that is able to accurately read the text fields on the film images that were created by focusing a 70 mm film camera at a precision CRT display monitor and then photographed onto special recording film.

Digitizing the Planet

University of Arizona Uses OCR Software to Read Text-Field Data from Surveyor Missions

The University of Arizona's Lunar and Planetary Laboratory (LPL) is home to the Space Imagery Center, a Nasa Regional Planetary Image Facility. Founded in 1960, LPL was one of the few places engaged in studies of the solar system at that time. In 2015, Nasa partnered with the University of Arizona, providing funding to digitize the film images and data from the Surveyor moon landers that have been in storage since the 1960s. The goal is to create an archive for inclusion in the Nasa Planetary Data System (PDS), a collection of data products from Nasa planetary missions. As John Anderson, senior media technician at LPL, describes it, his "focus and primary area of responsibility is the digital recording of the images, extracting and decoding the encoded image data optically recorded on each film frame, and processing the pictures for viewing in a digital format."

Typical film image from Surveyor mission with a CRT display (left) and associated data fields (right)

The dot-matrix characters in the data field posed a challenge to be read.

Raw Materials

Between 1966 and 1968, the five successful Surveyor missions returned over 92,000 individual images of the moon's surface. Film images were created by focusing a 70 mm film camera at a precision CRT display monitor and photographed onto special recording film.

In the 50 years since, the computer files and video tape records have long disappeared or become obsolete – the only existing copies of the images are the film rolls.

Many frames from the Surveyor missions had seemingly legible text, which the operators initially thought could easily be read by conventional optical character recognition (OCR) software. They soon discovered that the characters in the text were a dot matrix similar to old printers using a 7 x 9 teletype-style character, making it a challenge to find an OCR software capable of accurately reading the text fields. A comprehensive OCR solution was needed.

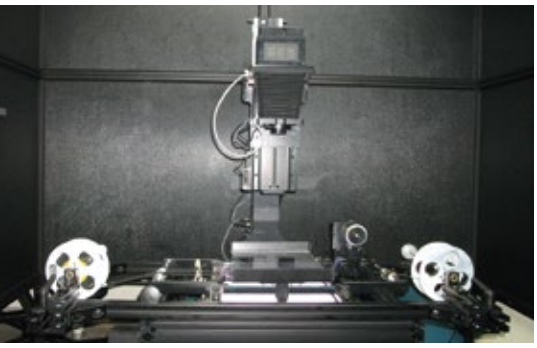
A Stellar Solution

This is where Matrox comes in. Anderson notes, "Lorne Trottier, co-owner of Matrox,

saw an article in Planetary Report about the Nasa PDS project. He reached out to the university through Arnaud Lina, director of research and innovation at Matrox Imaging, offering assistance using the company's OCR software to read LPL's text information. [LPL] selected some cropped images to upload for a test and the results were amazing. It was very encouraging, especially with the failure of other OCR products to read the human readable text (HRT)."

Mission Control

The overall project involves creating a searchable archive that will outlast conventional physical media repositories. Given the possible long-term reference potential of the images and data, there is need for careful and accurate treatment of the resources.
The workflow comprised an image scanning system from Stokes Imaging. This scanning system captured between four and eight frames per minute as high-resolution TIFF images. At the conclusion of the scanning phase, LPL found themselves with over 92,000 individual images.



The Stokes Imager used to digitize the image frames from the Surveyor missions.

Operator interaction was intensive during the original scanning process. While the imaging system was automated, the film itself was not uniform in spacing, indexing, exposure, or processing. Once scanned, Adobe Photoshop and Matlab software were used to pick out the details and create large composite mosaics from the image files. The process also required manual error checking since the decoding of the dot-field data relied on calibration lookup tables created from the original 1966 pre-launch test data.

We Have Liftoff

The project began in February 2015 with the assembly of the Stokes Scanner, and continues to process, catalog, and data-mine the information contained within the images.

Even though there are sprocket perforations on the film stock, the original recording transport was sprocket-less, resulting in inconsistent frame spacing as well as frames drifting with respect to the edge perforations. The team at LPL were unable to determine a consistent film advance, and with each new roll of film, the spacing of the frames and lateral positioning of the image shifted. This resulted in overall images with text in different places, as well as some images tainted with artifacts. Moreover, the data fields have HRT with varying number of characters.

Matrox's solution—based on one of its efficient and accurate OCR software tools – beautifully addressed the problem of reading dot matrix characters, and it reduced the time expenditure to a few minutes per roll.

The initial review of the OCR solution showed an almost perfect read from nearly 4,500 different image files. For example, for roll 1 of Mission 5, the OCR solution scanned 846 files, reading 15,191 individual fields for a staggering 99.77 % accuracy. Rolls 2 and 9 of Mission 5 were even better, yielding respective 99.92 % and 100 % accuracy rates.

Looking to the Future

The University of Arizona Lunar and Planetary Laboratory Space Imagery Center, a Nasa Regional Planetary Image Facility, serves as the repository for many images and resources from all Nasa missions. To date, the Matrox software has helped tackle data from Surveyor 5, and it will prove a valuable tool during the catalogue and error check of data from Surveyor 6 and 7, along with other mission materials from Nasa projects and explorations.

Conclusion

The OCR software has been an instrumental addition to the archiving project. Continued use of the system will accelerate the recording of text information from the Surveyor image files, enhance the accuracy of the metadata, and streamline what can be a very labor intensive and tedious task.

Anderson notes, "Compared with accuracy rates of 75 % to 85 % achieved with the original approach, there is no doubt as to the better result. Our project has been greatly enhanced and the progress of reading and cataloging the data with high accuracy would not have been possible without the assistance of the Matrox team."

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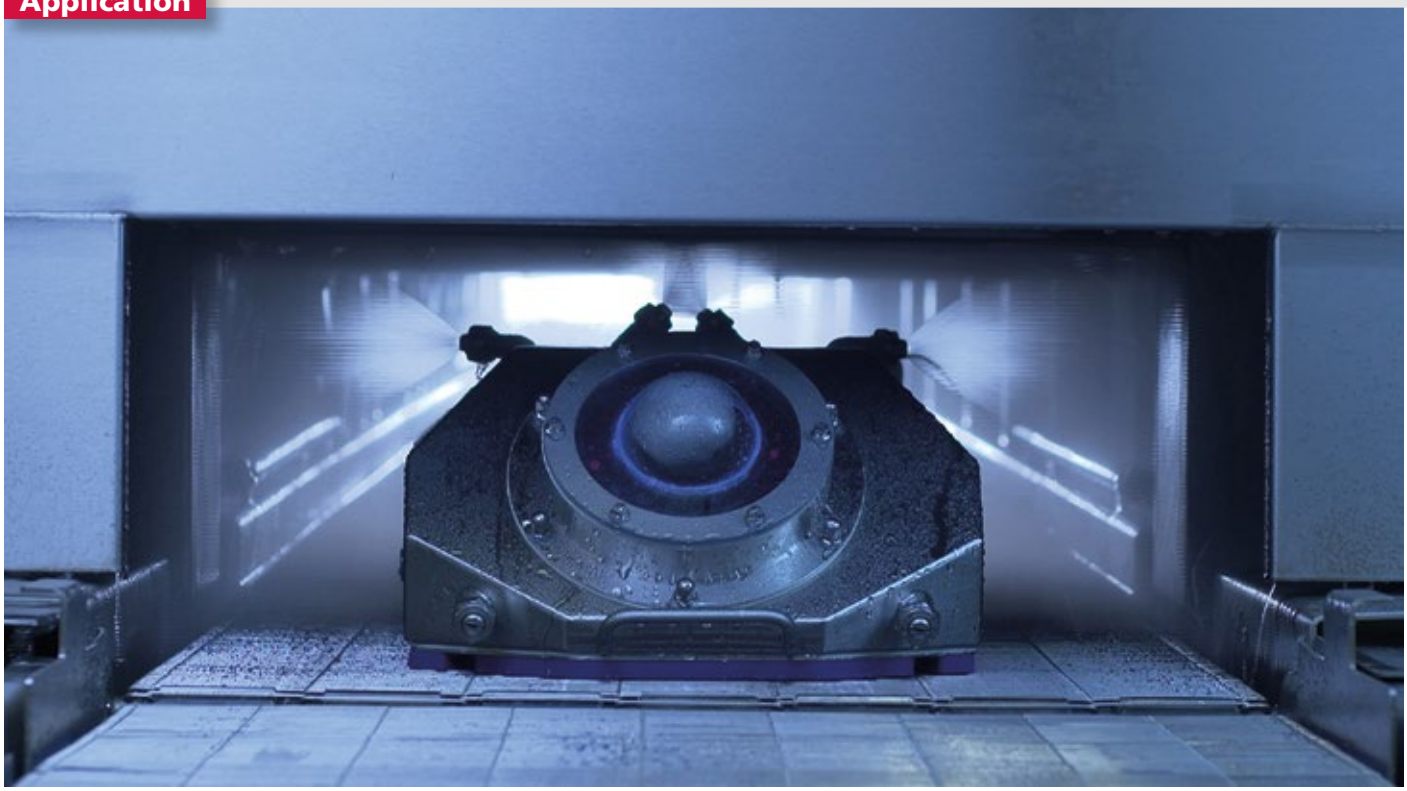

Photo: Fraunhofer IVV Dresden

Residue and Contamination Don't Stand a Chance

Optical Sensor System for Targeted Cleaning in Hygiene-Sensitive Areas

A new Mobile Cleaning Device is able to identify cleaning requirements, determine the relevant parameters for need-based and efficient cleaning and then carries them out autonomously.

The Mobile Cleaning Device (MCD) developed by Fraunhofer IVV Dresden has an optical sensor system for soiling detection that enables it to handle the entire cleaning process. For this purpose, the MCD is moved through the installation on the system conveyor belt. In this way the research experts have merged the flexibility of manual cleaning with the benefits of reproducible automated clean-in-place (CIP) processes to save time and resources while increasing process reproducibility.

Developing new cleaning technologies for hygiene-sensitive areas such as food and pharmaceutical production is a central research focus at Fraunhofer IVV Dresden. „Present-day cleaning processes orient towards maximum requirements and hence often waste time and resources," explains Roman Murcek, the MCD project manager at Fraunhofer IVV. Consequently, the industry has a strong interest in automated systems for non-contact, intelligent and targeted cleaning which in parallel allows for better validation of overall efficiency in the cleaning process. Especially with the ever-growing hygiene requirements in food processing, food safety is a prerequisite. Does the cleaning process consider critical spots susceptible to contamination? What's the type of contamination? What are suitable cleaning media? Was cleaning successful? In manual operations, such questions are answered and evaluated by people with the help of random tests on a local basis, for example by means of dip slide tests.

Cleaning Defined by the Degree of Soiling

The first MCD prototype was developed as part of the EU project „PicknPack" for the development of a flexible and modular packaging system. „Our task was developing a cleaning system where the modular architecture of the installation eliminated the use of conventional CIP systems," Murcek explains. The solution was a flexible mobile device for hygienic cleaning of every surface with product contact without the risk of cross-contamination.

Today the device features seven nozzles which, depending on type and degree of contamination, blast different cleaning media such as water or foam at a pressure of up to 10 bar. The MCD follows the product route on the machine's existing transport system. A self-propelled system, with the help of either an additional self-propelled module or directly mounted motors and wheels, has been designed for other cleaning tasks without a conveyor belt. While moving, the device emits

Photo: Fraunhofer IVV Dresden

The intensity of the cleaning operation is automatically adjusted to the soiling degree of the machine, with reproducible results and increased food safety.

UV light to detect fluorescent organic dirt particles such as grease residue by help of a camera. „In the most cases, the used UV light creates the best contrast, as the excitation produces hardly any visible light," Murcek describes. According to the detected amount of soiling and spatial dimensions, the MCD will accomplish any required cleaning operation such as foam application in differently soiled spots according to the requirements. Each nozzle can be individually controlled. Cleaning media, water pressure and temperature can thus be varied on one hand and used precisely in order to obtain the optimum result on the other. After prerinse, foam application and rinse the result is verified and recorded by the device. The rechargeable battery-powered MCD is WLAN-controlled. „The only physical interface is a hose for media supply," Murcek outlines. The hose connected to the supply station provides the device with water, foam or any other cleaning media – easily and without the need for nozzle exchange.

Flexible, Reproducible and Cost-Saving

The specialized design of the cleaning device provides great flexibility for use in various systems to increase food safety. Compared to manual cleaning operations done by humans, the device is more efficient, reliable and above all ensures reproducibility. „The MCD is capable of reaching spots inaccessible to men without the need for disassembling any machine parts," Murcek says. Additionally the researchers expect significant time savings. First cleaning tests at Fraunhofer IVV have already yielded cleaning media savings of about 20 % compared to conventional CIP cleaning systems. And last but not least, integrated image processing ensures consistent quality assurance and documentation of the cleaning process.

Sensors to Fight Dirt

The hardware centerpiece of the optical cleaning system is a CX series 5-megapixel GigE camera. „Among other manufacturers,

Continued on page 32

Photo: Baumer

MCD detects the degree of soiling by help of a CX series 5-Megapixel GigE Vision camera.

> *„First cleaning tests have already yielded cleaning media savings of about 20 % compared to conventional CIP cleaning systems."*

we have often used Baumer cameras in varied test stands, for example in cleaning process monitoring and quantifying or soiling detection on surfaces. Because of the good experience we also relied on Baumer for MCD development," explains Murcek. Good image quality and high camera sensitivity are key in detection of contaminants which are slightly fluorescent under UV light. With a resolution of 5 megapixel, the camera is also ideal for detecting small soiled spots within a large image area without loss of information. Thanks to third-party compatibility, image evaluation is supported by Matlab and Labview.

Selecting the correct cleaning parameters requires a spatial orientation of the MCD in the machine. For exact position determination, a Baumer IFBR 17 series inductive proximity switch with suitable mounting is used – with completely hygienic stainless steel design. For the last three years, Fraunhofer IVV has benefitted from the manufacturer's extensive experience in the food and beverage industry with optimally-designed sensors to meet the high demands of food production areas. The IP 69K sensors are jet-proof, corrosion-free and withstand high-pressure cleaning. The hygienically-designed, EHEDG-certified and Ecolab-approved enclosure is chemical-resistant and endures even aggressive cleaning media and disinfectants. The smooth sensor surface with no dead spaces prevents accumulation of dirt and contaminants and ensures hygienic, resilient and reliable MCD position detection.

The Virtual Twin as Future Vision

The cleaning device is under continuous development at Fraunhofer IVV as a showcase. „The current version still operates on defined process flow. Present research is about the completely autonomous control by means of a virtual twin of the cleaning installation as well as the software integration of the cleaning sensor system," Murcek explains. Supported by virtual twin simulations, the MCD would be able to determine the cleaning parameters all by itself. These parameters interlinked with the data supplied by the optical sensor system would make it possible to determine exactly where contamination is located. „The system's CAD data used in combination with specialized software for spray shadow simulation would allow for optimal cleaning processes without the need for extensive practice tests," says Murcek. In this future, the device's operation is all-autonomous – without prior programming of the process flow. There is strong interest in the industry, and discussions with potential users and sales partners are already underway to make this vision a reality.

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New High-Speed Trilinear Camera

JAI announced the addition of a new high-speed trilinear color line scan camera to its Sweep Series camera family. The new SW-4000TL-PMCL features a custom CMOS trilinear imager with 4K (4,096 pixels) resolution and a maximum full line rate of 66 kHz for 24-bit non-interpolated RGB output.

The new SW-4000TL-PMCL trilinear camera expands the options for designers of color line scan-based systems, which have previously relied on JAI's Sweep+ Series of prism-based RGB and RGB+NIR line scan cameras to deliver the maximum in color image fidelity, sensitivity, and configuration flexibility. The high performance trilinear technology in the SW-4000TL-PMCL has been combined with a broad set of advanced features – many of them unique among high speed trilinear cameras – to give designers an attractive alternative for applications not requiring the ultimate precision provided by prism cameras.

For example, the custom CMOS imager features not just three, but six separate lines of 7.5-micron pixels with two lines each of red, green, and blue pixels. This arrangement makes it possible for the SW-4000TL-PMCL to provide horizontal binning, vertical binning, or both – a feature not offered on other high-speed trilinear cameras. Furthermore, the sensor's readout architecture combines the readout of two pixels through a single diffusion node to double the signal without increasing noise, enabling the binning process to dramatically increase sensitivity. www.jai.com

New Camera Models

Allied Vision expands its Manta camera family with two new models incorporating second generation Sony IMX CMOS sensors with Pregius global shutter pixel technology. The Manta G-158 incorporates the IMX273 sensor, offering a resolution of 1.58 megapixels and a frame rate of 75.3 fps at full resolution. The Manta G-040 is equipped with the IMX287 sensor delivering a resolution of 0.40 Megapixels and a frame rate of 286 fps at full resolution. Slightly higher frame rates can be achieved in burst mode.

These new Manta models are especially suited for industrial applications that require accurate imaging of fast-moving objects. Due to their superior performance, these models will be the best candidates to replace existing CCD cameras with similar resolution and optical formats (e.g. with Sony ICX424 or ICX445 CCD sensors). Particular highlights are the three look-up tables, sophisticated color correction capabilities, a robust metal housing, and many modular options like a board level version. www.alliedvision.com

Real-Time GPU Processing Support

Active Silicon announced that all its frame grabbers are compatible with both AMD's DirectGMA and Nvidia's GPUDirect for Video. These APIs enable many filter, convolution and matrix-vector-operations to be performed directly on data from a frame grabber using a GPU without the need to be processed by system buffers or by the CPU. This makes data acquisition very fast with very low latency as the GPU memory is made directly accessible to the frame grabber. Modern GPUs are extremely efficient at processing images and graphics, and their parallel structure makes them particularly well suited to uses where large blocks of data need to be processed in parallel. The company published details on its website to help understand the processes involved when running both Windows and Linux OS, and the setup requirements for each one to help you know what's needed and how best to get started, including a video demo of GPU processing. www.activesilicon.com

Embedded Vision Camera Modules with MIPI CSI-2 Interface

Basler adds models with a BCON for MIPI interface to their dart camera module series. This innovative product concept combines the established MIPI CSI-2 interface from the embedded arena with the high camera standards and the typical long-term availability of the machine vision industry.

The dart camera modules with BCON for MIPI interface are well positioned to fully harness the ISP of select embedded platforms in the Qualcomm Snapdragon extended life product portfolio on a Linux Open Embedded operating system (Linaro). Basler supplies not only a high-quality camera module with 5 megapixel resolution and 60 fps based on the ON Semiconductor AR0521 sensor but also the appropriate driver package for controlling the sensor and image acquisition via the MIPI CSI-2 interface. Users receive an industry-ready, robust embedded vision system with outstanding image quality and no integration effort.

www.basler.com

Inspect Metal Components Faster

Olympus' new GX53 inverted metallurgical microscope features MIX observation for clear imaging of structures and surface features, an LED light source for true-to-life images with consistent colour temperature, and coded hardware enabling faster inspections and improved productivity.

Designed for the observation and inspection of metal components, the new Olympus GX53 inverted metallurgical microscope features an LED light source for ultra-long life and low power consumption. The GX53 microscope also incorporates the latest version of OlympusStream image analysis software (v. 2.3) for improved observation and reporting capabilities.

Inverted metallurgical microscopes observe samples from underneath, enabling the user to inspect thick or heavy samples without adjusting the orientation of the sample surface. This ability makes the GX53 microscope a practical tool for viewing the microstructure of metals used in automotive and other manufactured metal components.

www.olympus.com

New High-Performance Smart Camera

A brand-new, ultra-powerful smart camera is about to hit the market to help businesses in a wide range of industries streamline their operations. This smart camera, the Hawk MV-4000 from Omron quadruples the processing power of the previous generation. It boasts up to six times the frame rate of its predecessor, achieving real-time trigger response using an FPGA (field-programmable gate array). Building upon a 35-year history of development in Automatic Identification and Machine Vision, the Hawk MV-4000 does code reading, code verification, inspection, guidance, and gauging, incorporating state-of-the-art algorithms that can serve applications in virtually any industry.

Users seeking high-quality images and a high level of configuration flexibility will appreciate this camera's wide array of sensors, ranging from 0.3 MP to 5 MP with a pixel size of 4.8 µm. The system can be optimized for almost any application thanks to these sensors in combination with C-Mount lens options and plug-and-play external lighting. Automotive applications will benefit from the Hawk MV-4000's long-range imaging and superior field of view. The consumer electronics industry will benefit from the camera's precision gauging and inspection capabilities.

www.microscan.com

3,500 Fps High Speed Camera

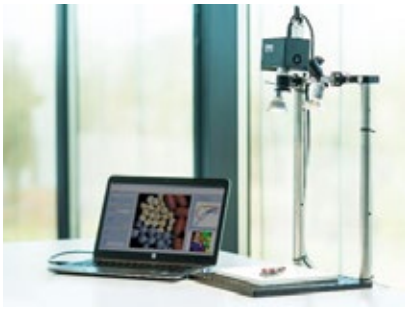
Following the release of the initial model with 12 Mpix at 333 Fps, Ximea is now ready for orders of two additional versions with speeds up to 3,500 frames per second. The fast PCIe interface allows the xiB-64 camera family

to stream data at speeds as high as 64 Gbit/s over distances of up to 300m without the need of expensive frame grabbers or special, complicated software. Resolution range of this camera line starts from 1 Mpix to 16 Mpix and is further enhanced with a Canon lens EF-mount that allows remote control of aperture, focus and image stabilization. First 4K model called CB120 equipped with CMV12000 sensors from Cmosis was introduced a while ago. With the help of new generation of PCI Express referred to as PCIe 3.0 this 12 Mpix sensor is able to reach the remarkable speed of over 330 Fps at full resolution. The camera's data and control interface are fully compliant with PCI Express External Cabling Specifications, which allows real data throughput of 7,000 MB/s – more than other industrial camera interfaces can compete with.

First of the newly available models called CB013 introduces a special, high-speed sensor from Luxima – Lux13HS. These sensors have especially large 13.7 µm pixels and fast data throughput with potential 3,500 Fps at a full resolution of 1,280 x 864. Both aspects are beneficial for high speed, low exposure time applications.

www.ximea.com

Camera for Hyperspectral Imaging Acquisition



Imec's new Snapscan camera handles all scanning internally using the miniaturized ultrasonic piezo scanning stage, thereby excluding the need for external scanning movement. Today, spatial resolution of 3,650 x 2,048px (7MPx), with a spectral resolution of 150+ spectral bands can be reached over the VNIR spectral range (470 to 900 nm) and the NIR range (600 to 975 nm). With Imec's proprietary hyperspectral imaging acquisition software, specific spectral regions of interest can now be selected, which enables acquiring images at a very high speed of only 200 ms. Flat signal-to-noise ratios of 200:1 over the full spectral range are in reach, with optimized acquisition and lighting set-up parameters.

"We believe our new high-speed ultrasonic Snapscan camera technology will further open the market for all users who intend to bridge the gap between academic research and commercial development. The second generation ultrasonic high-speed Snapscan camera ability to easily create high quality datasets will enable our partners to move from initial application validation to building consistent spectral libraries and application solutions faster than ever possible before," explains Jerome Baron, business development manager at imec's integrated imaging and vision system teams. "With a full year of commercialization under our belts, we have validated many clear commercial opportunities beyond the R&D market such as the medical market."

www. imec.be

Checking Power Semiconductor Devices in Production

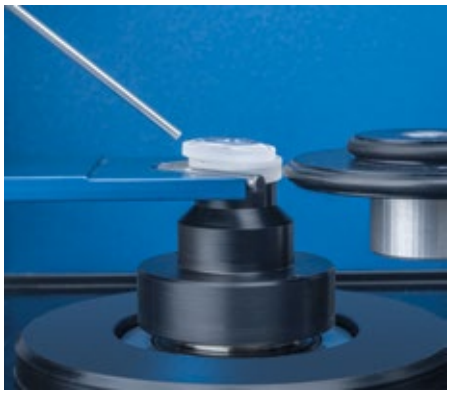
Ixys UK Westcode, part of the global power semiconductor manufacturer, Ixys Corporation, is investing in its Chippenham, UK factory to manufacture a new range of power semiconductor devices, which will be marketed alongside the company's long-established Press-Pack Capsules. Nikon Metrology (www.nikonmetrology.com) was chosen to supply the all-important X-ray equipment for checking the quality of the reflow soldering process during production.

Power semiconductor devices are used for switching high currents and voltages and are widely used in the rail, wind turbine, mining and petrochemical sectors. Press-Pack capsules are clamped together under high pressure to achieve the required electrical rating, whereas isolated power modules use integrated circuit on DCB (direct copper bonded) substrate technology. The Nikon Metrology XT V 160 is needed because the reflowed solder, which attaches the chips to their contact pads, must be continuous with a controlled level of voids and X-raying is the only way to see if these conditions have been met.

www.nikon.com

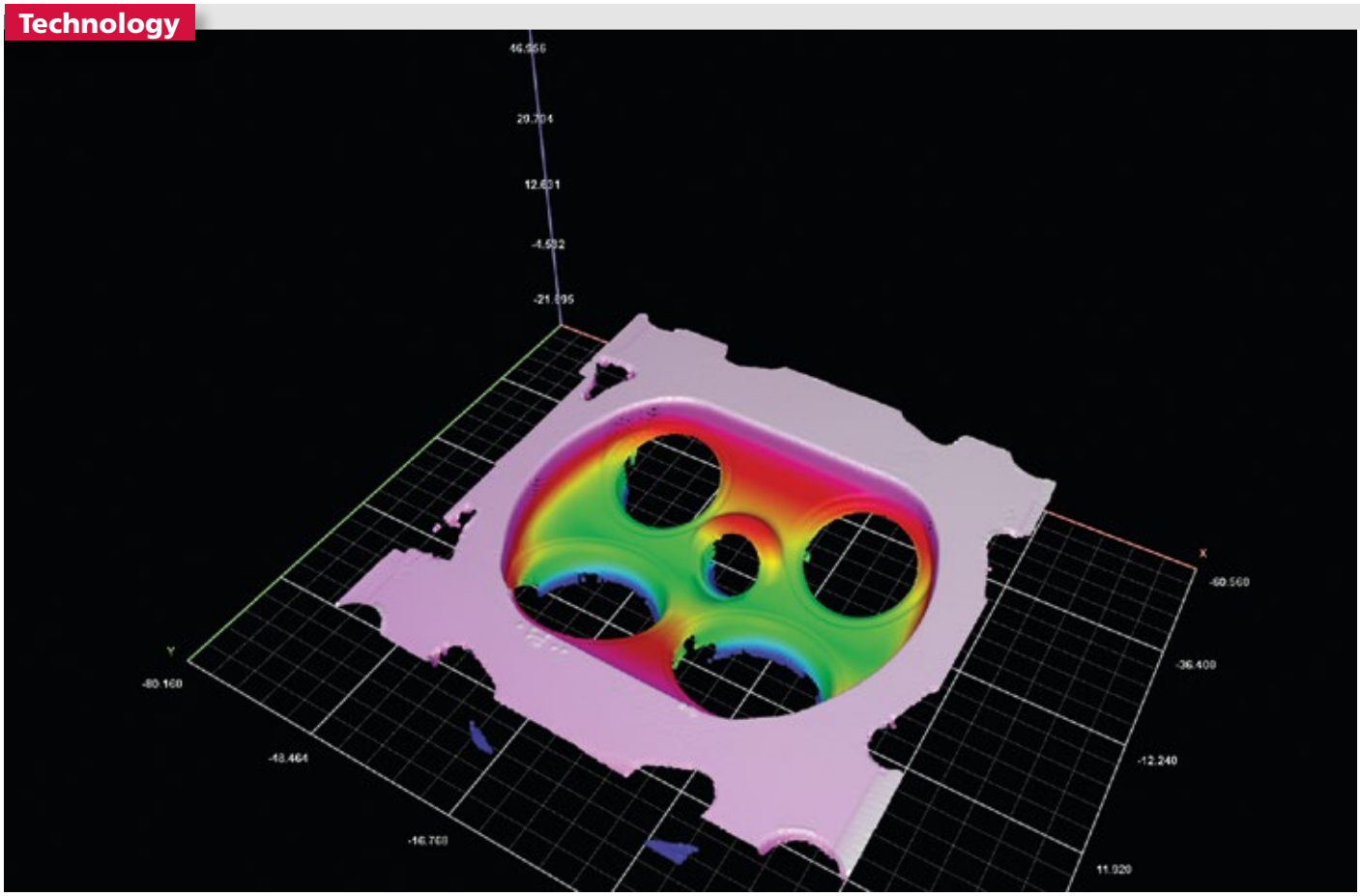
Automated Alignment of Doublets

At present, two methods are primarily used for aligning doublets: manual alignment and automated active alignment. Since switching between these methods is a big step both financially and procedurally, many users of the traditional manual method are wary about making the change.



In traditional doublet cementing processes, the measurement is done on a lens rotation device, for example. With this method, the edge of the lower lens is joined to a V-edge and the lens is rotated using a friction wheel. The upper lens can be aligned manually by tapping it into position or by using a manually-operated air manipulator. "However, these conventional alignment methods often reach their limits nowadays," explains product developer Tobias Schenk. "These limitations affect both the efficiency, which can hardly be increased in the manual processes since they are already fully developed, as well as the quality assessment of the final alignment result. Since the alignment is frequently assessed on a purely visual basis, a certificate of completion usually cannot be created." To address this problem and close the gap between conventional and automated active alignment methods, Schenk has developed a new alignment module: the LensAlign 2D Air for devices in the OptiCentric series. This is a cost-effective entry-level solution in the range of Trioptics LensAlign modules, bridging the gap between traditional manual alignment techniques and automated active alignment.

www.trioptics.com



The Volume Checker

Delivering Application-Specific 3D Inspection Solutions through Firmware Customization

A flexible smart sensor platform supports model customization at manufacturing level. This approach allows users to configure standard sensors to serve application-specific requirements for a particular industry.

A development kit called Gocator Development Kit (GDK) is the primary enabler of LMI's application-specific approach to 3D sensor design. Using GDK, developers can embed their own custom measurement algorithms onto a Gocator sensor with the same functionality as built-in native tools – which in turn gives users the ability to perform highly specialized measurement tasks. Custom algorithm development is achieved using Visual Studio in ANSI C, with no need to learn a new IDE/Development Environment or programming language. Users simply develop their measurement tools, build them into a custom binary firmware library, and upload the custom firmware to a Gocator sensor.

Use cases include:

- Applications that require specialized algorithms to process captured data.
- Applications that are upgraded to smart 3D sensors where algorithms are already available in the form of pre-compiled libraries, which can be accessed from within a custom tool running in a hardware accelerator.
- Applications where the users intellectual property (IP) must be protected from exposure to third parties. In this case using a custom sensor tool ensures the IP stays within the company.

The Volume Checker

In specific cases LMI will design a custom measurement tool expressly for the customer and their application. Gocator Volume Checker is an example of the power of this process at work. Leveraging 3D snapshot sensors, the GDK, and several supporting technologies, LMI designed the tool to provide a fully customized 3D solution for high-speed, accurate volume measurement of engine cylinder heads and piston bowls in small to medium-sized internal combustion engines (ICEs). As an automated 3D non-contact solution, the solution effectively replaces manual measurement approaches for automotive tier two and three component suppliers.

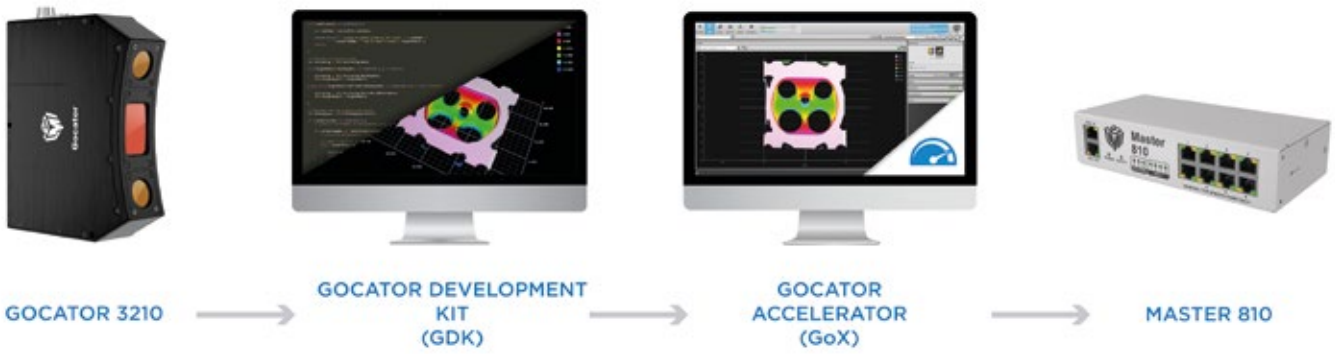
About Engine Volume Gauging

Each cylinder in an engine block has to be measured for correct combustion volume. While CAD data can be used to determine nominal volume, compliance testing requires the acquisition of a large number of measurement points, their connection by line or curve approximation, and finally computation of volume displacement.

Traditional Contact-Based Methods

Tactile coordinate measuring machines (for example CMMs) can accomplish volume gauging with a high degree of accuracy. However, this method can take more than two minutes per chamber, where all chambers need to be measured.

As a result of the slow speed and high cost of CMMs, the vast majority of manufacturers use liquid (a technique known as litering) to measure engine volume. Acoustics and



The complete Gocator Volume Checker solution.

pressurized air are less commonly used contact-based methods. All three of these traditional methods are time-consuming, because there is significant setup time involved and only one cylinder can be measured at a time. Additional time is required for clean up after measurement is completed.

The Advantage of Optical Methods – Structured Light

Optical methods based on structured light (fringe projection) offer a 3D scanning method that is non-contact and area based. 3D

Gocator Volume Checker inspecting engine cylinder heads.

scanning with this method is significantly faster (seconds, not minutes) and produces much higher density 3D data, representing a more accurate shape of the part. Snapshot sensors deliver this type of 3D scanning technology. A structured light 3D snapshot sensor projects a line pattern onto the cylinder head of an engine block. The line pattern is recorded by a camera from an optimal angle, yielding information on the cylinder's surface topology calculated from the deformation of the projected lines. Stripe pattern projection provides coordinate resolution down to 1/50 of the projected stripe width. This means the cylinder head can be fully inspected with the acquisition of just a few dozen images with slightly shifted stripe positions, i.e. phases, which can be accomplished in just a few seconds.

Gocator Volume Checker – The Components of a Custom Solution

Volume Checker is made up of several components, of which GDK is the operative technology in achieving customization.

1. Gocator 3210 Snapshot Sensor – Hardware

Gocator 3210 is the hardware platform of the Volume Checker solution. The 3210 is a metrology-grade, inline ready snapshot sensor that scans at 35 µm resolution, and it is ideal for detecting features on large targets such as automotive cylinders. Features are a fast scan rate (4 Hz full-field), a stereo camera design that minimizes occlusions, a small form factor for easy system integration, and a wide field of view (FOV) up to 154 mm.

2. Gocator Development Kit (GDK)

The GDK allows developers to embed their own custom measurement algorithms into the Gocator firmware with the same functionality as native tools. Custom tools allow users to perform specific measurement tasks. In the case of the Volume Checker, LMI has embedded a custom volume gauging tool that can scan and measure cylinder heads in less than five seconds at an accuracy of +/- 0.04 cm^3.

Application Examples

The benefits of the GDK are not limited to volume checking applications alone. It has been used to successfully create custom solutions for:

- Battery flatness inspection – Custom tool combines multiple scans of the battery surface, corrects for tilt and overlaps, and calculates overall flatness.
- Peak detection in various materials – Custom tool detects all peaks in a profile and outputs the coordinates.
- Height measurement in non-uniform part inspection – Custom tool measures the heights between various positions and outputs measurement value and control decision.

In all of these cases the GDK gives users complete control over how and where their custom measurement tools are used, therefore safeguarding their valuable intellectual property. Plus, custom algorithms are easy to troubleshoot on-site, which allows for rapid response to urgent client issues and reduces integration time with existing systems.

3. Gocator Accelerator (GoX) – Sensor Acceleration

GoX is an important supporting technology in the Volume Checker solution. This PC-based application accelerates the Gocator 3210 sensors by offloading compressed 3D scan data to a PC – for unpacking and analysis – to achieve the fast cycle times required for inline engine block inspection.

4. Gocator Multi-Sensor Networking Capabilities

In the "smart" automated factory, networked smart 3D sensors connect with factory infrastructure to report results, web browsers for diagnostics and monitoring, the Internet for upgrades, and even with other sensors to exchange or combine data. Gocator Accelerator unpacks, stitches, and generates new point clouds with data from networked sensors.

The Master Hub 810 network controller simplifies the support of multiple sensors (up to eight) by handling power, synchronization, laser safety (for laser-based sensors), encoder, and digital I/O. A Master 810 is used to support the Volume Checker when you want to use four such sensors to scan and measure four cylinders at once.

Gocator Volume Checker demonstrates how 3D smart sensors, custom measurement tools, PC-accelerated applications, and hardware synchronization can be combined to solve specific applications that can't be achieved using standard measurement solutions.

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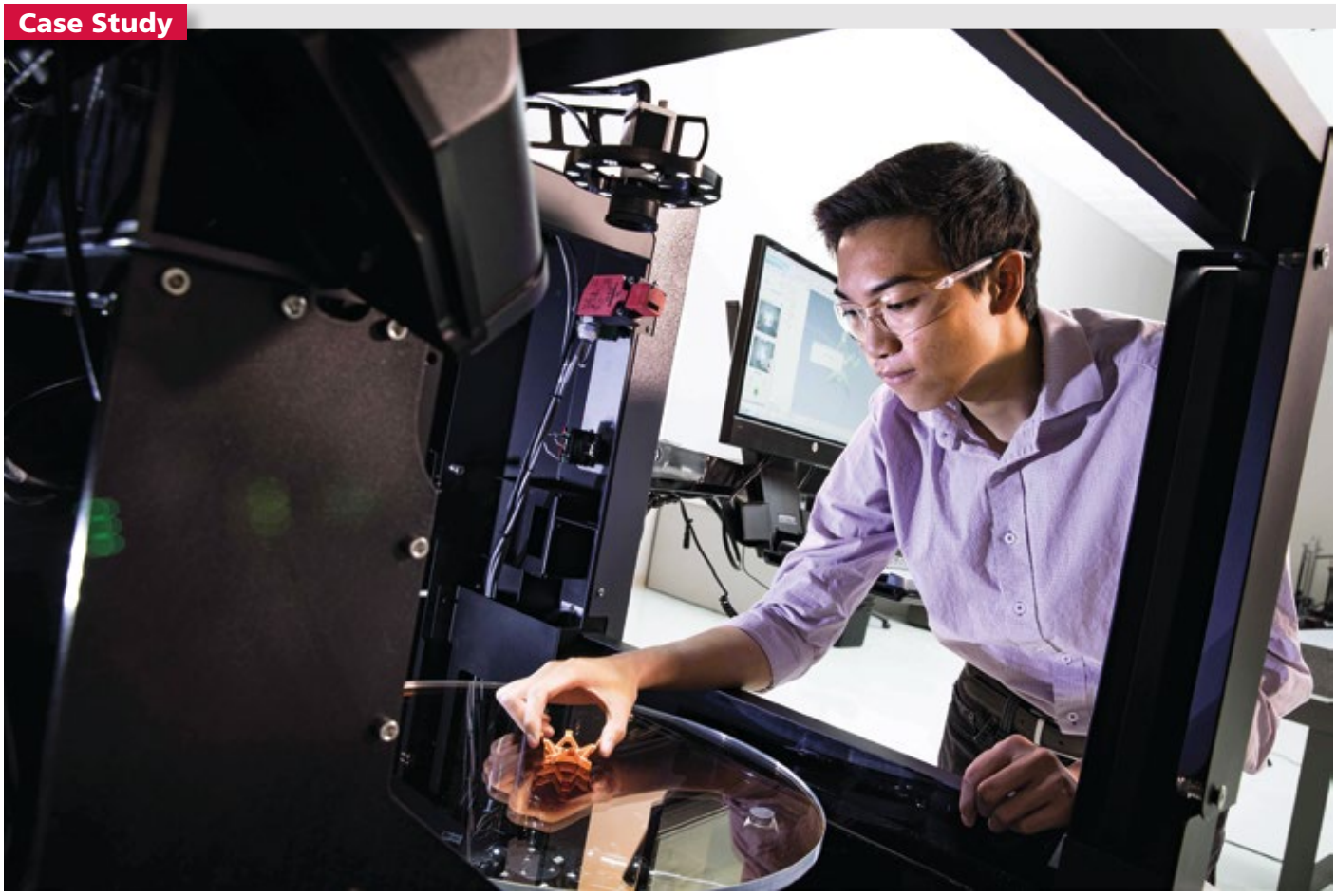


Elevate and Accelerate

Improve Time to Market with 3D Scanning and Inspection Technology

The digitization of the entire manufacturing process enables the production of commercial-grade plastic, metal and liquid silicone rubber parts in a timeframe of just a single day.

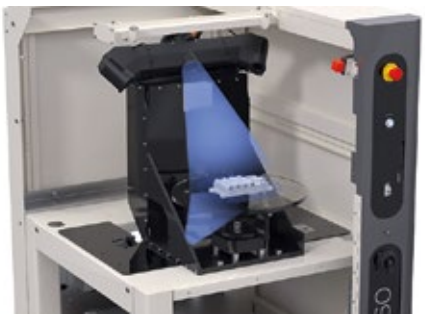
Proto Labs is the world's fastest manufacturer of custom prototypes and on-demand production parts. The company offers services in 3D printing, CNC machining and injection moulding. Its client base encompasses an array of industries including aerospace, automotive, electronics, medical, robotics and alternative energies. Central to Proto Labs manufacturing excellence is the constant strive to reduce customers' time to market. In order to achieve this, it has digitized the entire manufacturing process, from automated quoting through to the proprietary processes on the manufacturing floor. This enables the company to produce commercial-grade plastic, metal and liquid silicone rubber parts in a remarkable timeframe, notably as fast as a single day.

Fast speed metrology for complex parts

Metrology and quality inspection form an integral part of Proto Labs' manufacturing process and are cited as an important requirement by its customers. As a manufacturer of prototypes and low-volume production parts, the company handles a broad spectrum of unique parts ranging from simple geometries through to those that are highly complex. It is therefore crucial that their metrology solution is capable of accurately scanning all of these geometries, and equally, in as fast a time as possible. They were also faced with the challenge of finding an efficient way of digitizing inspection reports, in a bid to maintain the digital thread and in response to customer demands. Traditional ways of measurement, such as CMMs (coordinate measuring machines) often require lengthy set up times and manual touching. For this type of application, such systems are simply not fast enough and do not align with the rest of their manufacturing process, which focuses on automation and speed.

One-Button Automated 3D Scanning and Inspection System

In a bid to overcome the limitations of traditional measurement solutions, the company adopted the Cybergage360 systems in their state-of-the-art metrology lab in Minneapolis, USA. The ultra-fast metrology-grade, automated 3D scanning and inspection system offered the 'one-stop' solution they were looking for. With just one button, it carries out a highly-precise 360-degree 3D scan of complex parts and a full 3D inspection report can be generated in less than three minutes.



With just one button, the CyberGage360 conducts a highly precise 360-degree 3D scan of complex parts, accurate to 7µm.

The solution greatly facilitates quality assurance by allowing anyone to be an inspec-

CyberOptics' automated 3D scanning and inspection system, the Cybergage360, on site at Proto Labs manufacturing facility in Minneapolis, USA.

> *"The unique sensor architecture simultaneously captures and transmits multiple image data in parallel while proprietary fusing algorithms merge the data together."*

tor of in-process and incoming/ outgoing parts on the manufacturing floor or in the metrology lab. After a part is rapidly manufactured, it gets immediately transported to the Proto Labs metrology lab and placed inside the CyberGage360. With little training, anyone can check parts for any deviation from CAD or check critical features. The machine's speed and efficiency has allowed for it to fit seamlessly into the existing digital and time-critical processes, causing no disruption to the production floor.

The Cybergage360 is powered by CyberOptics' breakthrough 3D Multi-Reflection Suppression (MRS) sensing technology that enables metrology-grade accuracy by inhibiting measurement distortions. This unique sensor architecture simultaneously captures and transmits multiple image data in parallel while proprietary fusing algorithms merge the data together. The result is a highly precise 3D scan and inspection report with accuracy to 7µm, 0.007mm + L/10,000mm, in less than three minutes.

As a result, Proto Labs' customers can now obtain digital inspection reports in the same, or almost the same, lead-time as they were getting their parts - something which is unprecedented in the industry. Customer satisfaction is increased not only because their product to market time is further accelerated, but also because the cost of quality is reduced.

The Cybergage360 system

Commitment to Digital Manufacturing

Another important component of the prototype and production part manufacturer's ethos is its commitment to digital manufacturing. The industry is experiencing a shift towards the utilization of Product Manufacturing Information (PMI) that can be inputted directly into Solidworks CAD models. The CyberGage360 facilitates this by enabling their customers to put all the PMI directly on to their CAD model, in keeping with the existing digital processes, and which completely eliminates the need for a drawing. The information can then be processed automatically, which translates to quickly, and reports and qualitative information are generated, subject to the customer needs.

Dylan Lundberg, Senior Manufacturing Engineer of Protoworks (Proto Labs' R&D lab) explains, "from our front-end services to our proprietary processes on the manufacturing floor, you will find three consistent objectives: it's fast, it's easy, and it maintains the digital thread. The CyberGage360 comfortably satisfies all three of these needs. It is the synergistic solution we were looking for to be at the focal point of our lab and future metrology offerings."

Unrivaled Solution to Streamline Path to Market for Customers

The key tenet of Proto Labs quality policy is its commitment to delivering quality parts faster than any other manufacturer, and meeting or exceeding customers' expectations. With the CyberGage360 it can now provide inspection reports faster than any other system in the world, this leads to an unrivaled combination for customers as they can deliver both services with unprecedented speed.

"It was a natural extension of our technology-enabled manufacturing approach as we aim to provide product developers and engineers with a total solution to streamline path to market," explains Vicki Holt, Proto Labs President and CEO. "The CyberGage360 has proven that it more than meets what we need as far as proving tolerances and proving dimensions for our customers."

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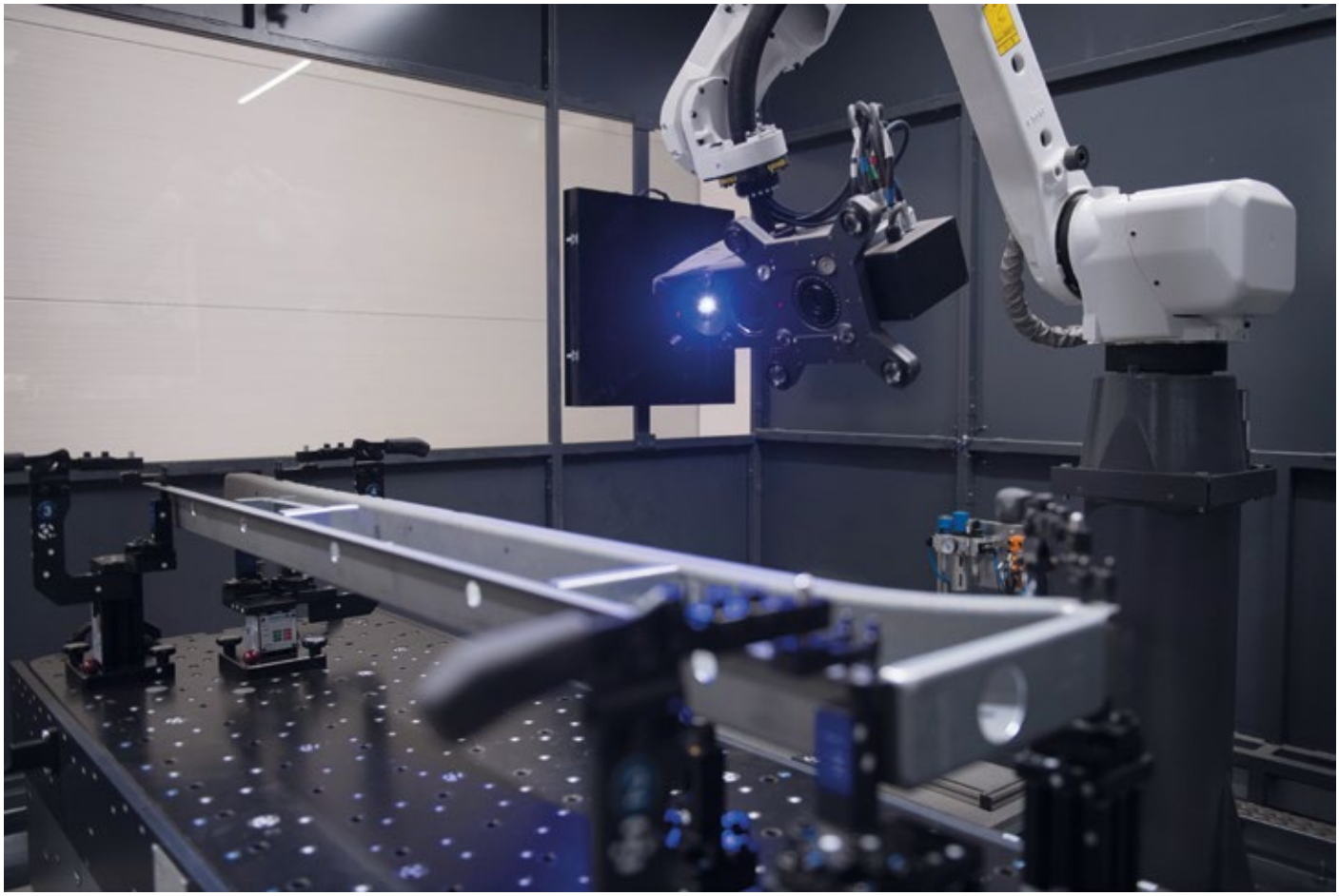

© Zeiss

One-Stop Shop

Manufacturing and Quality Assurance Technologies for Automotive Part Inspection

There is one critical, little-known success factor for automotive manufacturers: the manufacturing know-how of OEM suppliers, who currently generate over 75% of the value added for a vehicle. Yet, their success can only be assured if they perform proper part inspection.

The region's strategically advantageous location and the availability of a highly skilled workforce brought the Spanish automotive supplier Gestamp to Louny in the border region between the Czech Republic and Germany. Back in 2011, the company constructed "one of our cutting-edge factories out in the countryside, not far from our customers like BMW, Audi or VW," says Ignacio Fernández Landa, senior process control systems and procedures engineer at Gestamp.

Hot Stamping of Parts

A total of 560 employees produce more than ten million car body parts like A- and B-pillars, cross car beams and bumpers. And there is more on the way as the range of products coming out of Louny expands. "Hot stamping technology presents an enormous opportunity for us to combine car safety with climate protection goals," says Fernández Landa. Unlike cold stamping, hot stamped parts are significantly sturdier and more stable. And this is all possible even though hot stamped parts are more than 20% lighter than those manufactured using standard methods – a decisive factor for automotive manufacturers who are increasingly legally obligated to reduce their vehicles' CO_2 emissions.

Perfectly Shaped

In Louny alone, Gestamp manufactures more than 230 different body-in-white parts for a total of 13 OEMs. One particular reason for this success is the company's ability to master hot stamping, a particularly tricky process. Sheet metal with different thicknesses and even made of different materials is reshaped to form a complex component in a single step. This makes it possible for one component to meet different strength requirements and feature both high-tenacity areas as well as a crush-collapsible zone. Fernández Landa cites another benefit: "Hot stamping allows us to create components in a single process as opposed to assembling multiple parts. You really notice the increased speed in the manufacturing and assembly process." Currently, Gestamp operates 75 hot stamping lines worldwide. At the beginning of every single production line, a robot lifts the unformed metal blank

> *"Hot stamping allows us to create components in a single process as opposed to assembling multiple parts. You really notice the increased speed in the manufacturing and assembly process."*

from a pallet and gently places it on a roller conveyor every couple of seconds. The roller conveyor then moves the blank into a feed oven approximately 50 m long, with an effective length (where the part is being heated) of 36 m. Here the blanks are heated up to 900°C. At the end of the oven, another robot picks up the glowing-red metal and positions it precisely in the forming press, which reshapes the material at about 750°C. The metal in the press is cooled down to a temperature ideally below 270°C, based on quality of the form – contact with the part, flow of cooling water. That happens in just a few seconds, creating the martensitic internal structure responsible for the metal's high hardness value. Due to the material change, it is difficult to use traditional machining tools to drill boreholes into the parts. Thus, laser cells are used in Louny to give these extremely complex components their final shape. A laser beam cuts all the necessary holes with great precision while also removing excess material. These 18 cells at Louny are loaded by employees who also immediately inspect every 10th to 15th part then and there.

An Impressive Solution

In addition to the numerous benefits of hot stamping, the process presents one challenge that can affect the manufacturing process. The tool pressure with hot stamping is significantly higher than with cold stamping, which requires new molds to be created and the old ones to be changed out more frequently. To meet the increasing quality specifications from the OEMs while simultaneously monitoring the manufacturing process even more closely than ever before, Gestamp began to look for a new approach to quality assurance in 2016. "Over the last couple of years, it became clear to us that we needed to measure more parts to offer our customers an optimum product," explains Michal Pelc, vision specialist at Gestamp in Louny. Everyone involved agreed that the company's goal of inspecting 33,500 parts per year would simply not be possible with the existing coordinate measuring machine. Moreover, Gestamp also wanted to use big data analyses for making important manufacturing decisions: "This meant that we would have to acquire, store and analyze more quality data," says Fernández Landa. The big challenge was to find a system that could measure the parts more quickly while still being extremely accurate. Even though Gestamp did not specify a preference for a particular measuring technique when describing what they required, Raphael Putseys, Global Key Account Manager at Zeiss, understood quite quickly that "as an optical system, the Zeiss Aibox would fit in ideally along the production line." As Putseys and his company see it, they are a solution provider. "Thus, an interdisciplinary team and I in Oberkochen developed a comprehensive proposal. We first collected different ideas, and then assembled our individual solutions to create a customized system that was a perfect fit," explains Putseys. The team making the decision at Gestamp was impressed by the suggested solution. After comparing offers from competitors, the company decided to purchase the entire Zeiss package: an Aibox with the Comet Automated optical sensor, the Piweb data management software, the fixturing system with a feeding solution, and multi-week on-site support to get the system up and running.

The Solution at Work

Since the beginning of 2017, the Aibox has been in operation at the plant in Louny, checking up to 500 characteristics on a component within 10 to 15 minutes. The Comet Automated sensor uses LED illumination and provides the necessary, very precise measuring results, allowing Gestamp to ensure that it maintains the required tolerance of +/- 0.3 mm for several components. Those parts that are machined with a laser following hot stamping or that have already been welded together or assembled are measured in the Aibox. The size of the particular random sample per lot size is determined based on the requirements of the OEMs and the company's own targets. The goal is to measure 33,500 parts per year with the solution. "Without the Zeiss system, we would need at least three contact measuring machines to perform the same tasks," says Pelc. Although the system has only been in use for several

Continued on page 42

© Zeiss

The hot stamped parts are given their final form in the laser cells. After machining, the employees perform random sampling to ensure fitting accuracy.

© Zeiss

The parts are heated to 950 degrees and placed in a press to shape them.

> *"Without the Zeiss system, we would need at least three contact measuring machines to perform the same tasks."*

months, Fernández Landa also sees the system as a success: "We are really pleased that we have a solution that has met all our expectations." In addition to precision, there is another key reason why the company is confident it made the right choice: "We developed a solution that has significantly sped up loading the Aibox and saved space," says Putseys. Here the fixture systems come into play. Thanks to their modular design, customers are able to store all fixturing equipment for the individual parts in a storage unit measuring around five meters in height. Pelc and his colleagues simply remove the appropriate fixturing equipment for the part that needs to be measured and screw this onto the four stationary loading tables not even 10 steps away from the cabinet. This makes loading the AIBox as easy and convenient as fixturing. The pallets with the fixtures are just pushed from the pallet onto a mobile table and directly into the measuring range of the Aibox.

Benefits at a Glance

"Without this loading system, we would have needed to expand the assembly area," says Fernández Landa. Pelc demonstrates how easy it is to operate. He picks up a hand scanner to capture a barcode on the loading pillars used to automatically run the corresponding measurement program. In order to prevent collisions and faulty measurements, a camera in the Aibox captures the workpiece and automatically checks that the component on the measuring table is the right one for the measurement program. "This significantly simplifies handling and completely eliminates any risk of mistakes," says Pelc. Zeiss was on-site programming the measurement software for the 20 different parts inspected in the Aibox, leading Gestamp through the process. Once learned, Gestamp programmed the rest of the parts. This enabled Gestamp to start its inspections quickly. In addition to the level of precision and the efficient loading process, Gestamp also generates a large quantity of data with the sensor. This data is then statistically processed using Piweb. "To take one example, we are now able to determine when our pressing tools need to be replaced earlier," says Fernández Landa. "By offering a complete package comprising the measuring system, software, fixtures, loading system, programming and engineering services, the manufacturer was able to impress Gestamp management in Spain as a one-stop shop," says Putseys. The next step on the agenda is to implement the the solution currently being used in Louny at a new production facility in the West Midlands, UK.

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Products

New Stereo Line Scan Color Camera

Chromasens has expanded its highly successful 3DPixa family with the introduction of the world's first 3D stereo line-scan color camera to feature an optical resolution of 2.5 µm/pixel, an innovation that enables the capture of extremely detail-rich signals that up to now could only be achieved through complex multi-camera solutions.

A breakthrough in mechanical design, the Chromasens 3DPixa dual HR 2 camera sets a new standard in the drive for ever-increasing higher resolution and speed. By capturing ultra-high speed inline 3D measurements, the camera identifies micron defects in complex surfaces and automatically rejects the part before it enters downstream process chains. Semiconductor failure analysis, inline height measurements, and the inspection of miniature electronics benefit from the camera's 16 mm FOV and flexible line rates up to 21,200 lines per second. Adding to its versatility is the ability to combine both 3D and 2D color inspection simultaneously to open up new and unique applications in science, medical and industrial sectors.

The Chromasens 3DPixa dual HR 2 µm camera leverages a trilinear CCD line sensor (RGB) for performance characterized by minimal noise levels, high image contrast and low power consumption. Blooming effects or image artifacts caused by synchronization problems in less advanced trilinear sensors do not occur due to Chromasen's opto-mechnical design.

www.chromasens.com

Ninox 1280
Cooled HD SWIR

High Resolution Cooled Vis-SWIR Camera

Raptor Photonics has launched an additional member to its family of Visible SWIR cameras with the Ninox 1280, offering HD resolution for high end scientific and astronomy applications.

Using a 1,280 x 1,024 InGaAs sensor from SCD, cooled to -15°C, the Ninox 1280 offers visible extension from 0.4 µm to 1.7 µm to enable high sensitivity imaging. It will offer less than 40 electrons readout noise combined with one of the lowest dark current readings on the market. The camera will offer ultra-high intrascene dynamic range of 69dB enabling simultaneous capture of bright und dark portions of a scene.

Available with a 12-bit CameraLink output, the Ninox 1280 will run up to 60Hz. The camera will feature On-board Automated Gain Control (AGC) which will enable the best contrast image from low light to bright as well as an on-board intelligent three point Non-Uniform Correction (NUC) algorithm providing the highest quality images. The Ninox 1280 is cooled to -15°C offering both TEC and water-cooling options, significantly reducing dark current and enabling longer exposures.

Raptor VP of Sales & Marketing Mark Donaghy comments "Our customers have been asking for higher resolution FPAs for some time. The Ninox 1280 puts Raptor at the forefront of high resolution sensitive InGaAs camera technology. We see a range of applications that can be used with the camera including astronomy, medical and in-vivo imaging applications."

The camera comes with a range of analysis software including XCAP and Micromanager and a standard CameraLink frame grabber (EPIX).

www.raptorphotonics.com

Master Complex Tasks in Image Processing

With new SmartApplets, Baumer is the first camera manufacturer to introduce an innovative concept to quickly and easily increase the application-specific functionalities of cameras with FPGA-based image processing. SmartApplets can be conveniently transferred to the LX VisualApplets cameras by means of a firmware update so the camera is immediately ready for use. As a result, even non-expert users benefit from ready-to-operate solutions for common tasks in image processing without the need to build up special know-how in FPGA programming.

They are also no longer required to define image processing algorithms on their own, which allows for a more rapid response to market requirements and significantly cuts down on development costs. By the end of the year, the first six SmartApplets to solve common image processing tasks will be available on the Baumer website for free download: Binarization, HDR, Image Aggregation, JPEG, Line Scan Emulation und Object Extraction.

www.baumer.com

For Electronics Development and Testing

As the first Flir camera designed specifically for benchtop work in testing and analyzing the thermal characteristics of electronic components and printed circuit boards (PCBs), the Flir ETS320 aims to advance testing and diagnosis accuracy in the electronics industry.

The Flir ETS320 is Flirs thermal imaging solution for electronics testing in engineering benchtop environments. As the first Flir camera designed specifically for benchtop work in testing and analyzing the thermal characteristics of electronic components and printed circuit boards (PCBs), the Flir ETS320 aims to advance testing and diagnosis accuracy in the electronics industry.

The Flir ETS320 combines a high-sensitivity thermal camera – engineered for imaging PCBs and other electronics – with an adjustable, hands-free table stand to provide consistent, non-contact thermal testing through the entire electronics design, development and production process. By offering more than 76,000 points of temperature measurement, the Flir ETS320 offers the ability to monitor power consumption, detect hot spots, and identify potential points of failure during product development.

www.flir.com

High-Speed Spectroscopic Ellipsometry

As a comprehensive manufacturer of metrology- and deposition-tools, Ulvac developed an innovative high-speed spectroscopic ellipsometer for many deposition applications, such as PVD, CVD, ALD and others.

This novel spectroscopic ellipsometer can measure the thickness and optical constants of thin films at a dramatically fast speed. Its data acquisition time is as short as 10 ms. It does not require any active components for polarization-control, such as a rotating compensator or an electro-optical modulator. It creates great opportunities for new applications of the spectroscopic ellipsometry in which the compactness, simplicity, and rapid response are extremely important. The sensor head can easily be integrated into a deposition tool and successfully measure thin films in-situ and ex-situ.

For other applications, e.g. semi-conductors and solar cells, there a portable, manual, and motorized instruments available for wafer sizes up to 300 mm.

www.schaefer-tec.com

5.1 MP GS CMOS Camera Link Module in Cubic Size

Sony Europe's Image Sensing Solutions has announced a new cubic-sized module, the XCL-CG510 in its 5.1 MP range of Camera Link machine vision modules based on its GS CMOS modules. The 29 x 29 x 30 mm module, shrinks the footprint by a third (34%) and volume by 57% over its dual-cable 154-fps sister module – the XCL-SG510. The new color/BW modules use a 2/3-type Pregius GS CMOS sensor and single-cable Camera Link interface to deliver 5.1 MP images at 35 fps. Both variants are available immediately in mass production quantities.

As per the XCL-SG510, the new module includes a burst-trigger function, which is capable of continuous shooting at the trigger timing, and allows the specification of exposure interval, number of exposures, and exposure time.

The cubic camera also includes an area gain function that allows minor adjustments in the brightness of up to 16 individually-set areas. Additional features include defect correction, a 9-pattern user-set shading correction, and a 3x3 pixel filter, to reduce noise, emphasize edges and extract contours – with nine pre-installed filter-factor patterns.

www.sony.com

Inspect Where and When You Want

Cam β digital magnifier has been designed especially for applications where viewing, image capture, reporting and documentation are needed. Magnify, inspect and capture images at the touch of a button. As often you want, where you want and when you want. It can be used in hard to reach areas, such as high up inside large machines as well as remote locations to access wild flowers and insects. This portable electronic magnifier can also be easily stored and transported for access when needed. Making it extremely suitable for production environments.

Cam β (Cam Beta) digital inspection magnifier is ideal for roaming inspectors, documenting faults, or for inspecting immobile subjects. With a high resolution color display, easy button operation, simple image capture and download, you can inspect and capture quickly and simply. The handling is pretty simple, the images can be frozen at a touch of a button and if needed stored in the internal memory. All this enables an easy routine work.

www.visioneng.de

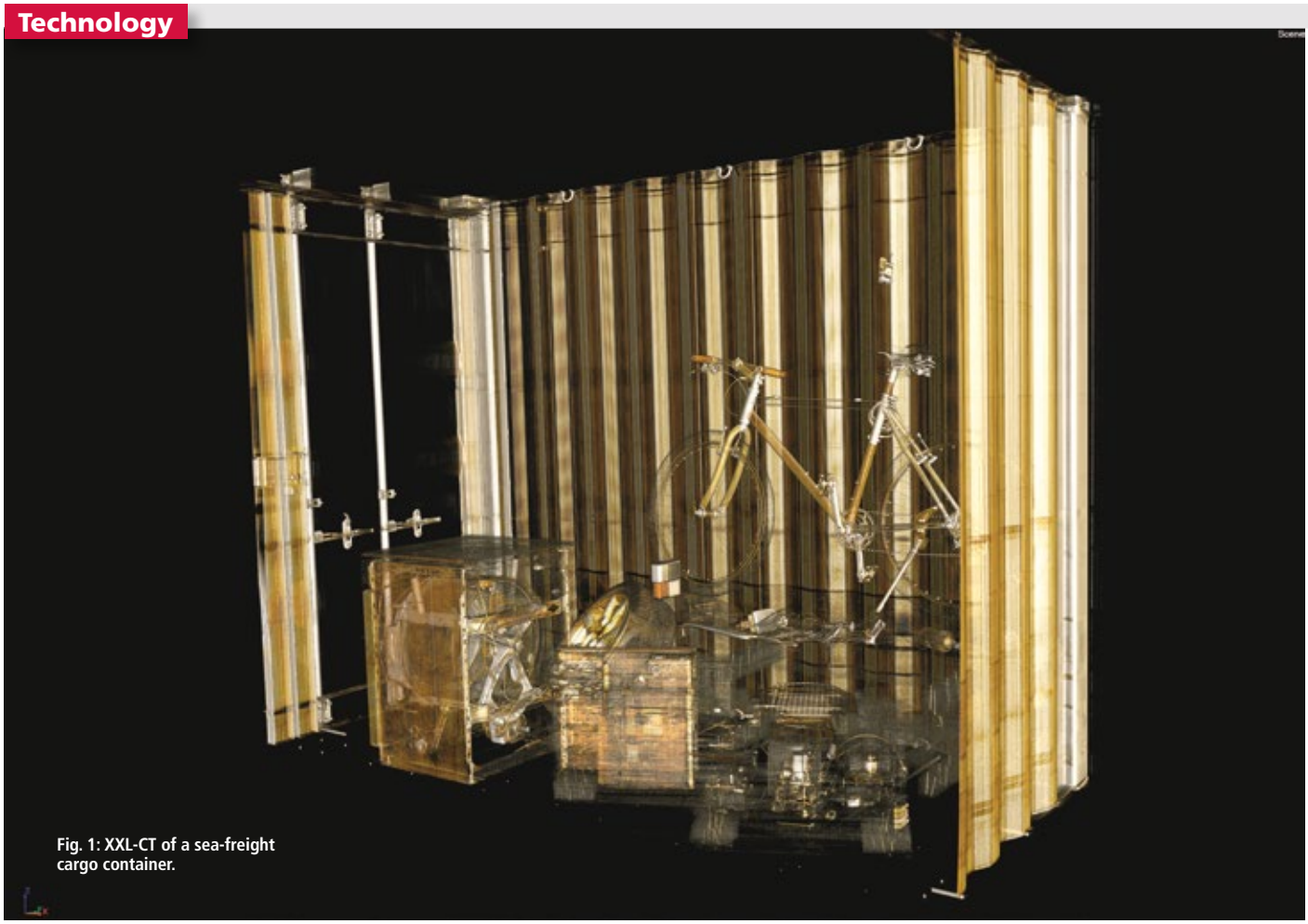

Fig. 1: XXL-CT of a sea-freight cargo container.

A Sharp-Eyed Giant

XXL-Computed Tomography for the Investigation of Very Large Objects

The XXL-CT, developed at Fraunhofer EZRT in Fürth, Germany is able to test large objects such as entire vehicles or items with difficult material properties. The powerful hardware and software make it possible to test final-assembled products and analyze them especially down to the nearest millimeter.

The XXL-computed tomography (XXL-CT) technology allows investigating very large objects three dimensionally. With the new developed computed tomography apparatus objects of up to 4.60 m of height and 3.20 m of diameter are captured non-destructively as a complete unit, i.e. without dismantling them into smaller components; this X-ray based method provides an insight into the opaque objects and allows to detect fine internal defects, structures and the complete outer as well as inner object geometry with high precision.

The following sectors provide fields of application for XXL-CT:

- Automotive: complete vehicles, engine blocks;
- Aerospace: aircraft fuselage, CFRP materials;
- Energy: turbines, rotor blades.

Further applications are considering the digitalization of historical goods for teaching and archival storage, paleontological artifacts or even the authenticity analysis of works of art.

The emerging application in the automotive sector is the analysis of crashed car structures. The XXL-CT provides an undisputedly unaltered insight into the deformation of the crashed structure without dismantling it and at much shorter processing time compared to the common manual approach. The technology is on its way to revolutionize the future design and optimization process of vehicle bodies.

The XXL-CT system which is installed in Fürth, Germany comprises a linear accelerator, a line detector and a turntable. X-ray energy ranges of up to 9 MeV can be reached, which is equivalent to 15 times the capacity of a conventional industrial X-ray system. This allows penetrating bulky steel objects with a thickness of approximately 20 cm or aluminum objects with a thickness of approximately 60 cm.

Generating Radiation on the Linear Accelerator

Unlike conventional X-ray tubes, linear accelerators are able to produce significantly higher X-ray energies. X-ray tubes are limited to around 600 keV. This is due to the use of high-voltage generators and their maximum feasible potential difference between the cathode and the anode. A linear accelerator requires just a comparably low initial potential difference and accelerates the electrons by means of a high-frequency electromagnetic field along the beam tube (consisting of cavity resonators). This type of acceleration can eliminate the need for

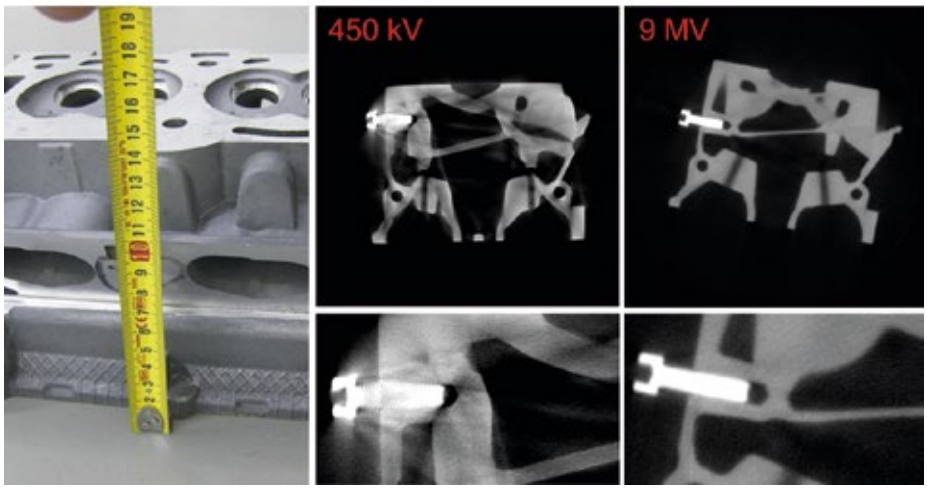

Fig. 2: Comparison of 450 keV and 9 MeV scans of an aluminum cylinder head.

> *"The technology is on its way to revolutionize the future design and optimization process of vehicle bodies."*

an elaborately insulated high-voltage generator. Instead, it requires a finely tuned electric oscillating circuit between magnetron, modulator and the cavity. This complexity requires significantly greater knowledge of the equipment than which is currently needed for X-ray tubes. X-rays are generated in the same way as in X-ray tubes by colliding electrons with an appropriate target, which emits a broad bremsstrahlung spectrum of photons. Although the X-ray energies, produced by this type of electron acceleration, seem to be infinite, there are still existing limits. These should especially be considered in technical applications, in order to keep operational costs low.

In the past, linear accelerators were mainly used to investigate large, safety-related products, which were difficult to inspect, such as reactor vessels. In this case, the circumferential weld seams were inspected using film-screen and imaging plate radiography. The advantage of this type of application is the high spatial resolution, which depends predominantly on the grain of the detective screen, as well as the downstream digitization process. The combination of high penetration length and high spatial resolution makes it an ideal method for analyzing materials, whose „damage characteristics" can be traced to local fine structures, such as weld seam defects. However, the low dynamic range of analogue radiographic screens in general and the low contrast detectability of approx. five percent difference in penetration length presents a drawback.

Digital detectors, which are state of the art in digital radiography at lower X-ray energies, are still rarely used in high energy applications. There are several reasons for this. In particular, the relatively large focal spot of a linear accelerator of minimum 1 mm in diameter does not allow applying high magnification ratios to the X-ray projection. However, digital X-ray detectors usually rely on high magnification to produce resolutions comparable to those provided by radiographic films. Moreover, damage to the detector electronics due to the high X-ray energies must be considered requiring a special detector design and appropriate shielding measures. Currently, digital X-ray detectors are mostly used for the inspection of cargo e.g. in sea-freight containers for customs investigation, in conjunction with linear accelerators (fig. 1). In this application, the resolution is less important than the size of the field of view, material sensitivity and scanning speed.

Properties of High Energy X-Ray Imaging

The interaction of high energy X-rays in the MeV range is based predominantly on the Compton scattering effect. In contrast to photon energies in the keV range, the photoelectric effect is negligible for nearly all materials, as shown in figure 2. However, this scattering effect, which generally has a negative effect on image quality, has significant advantages in particular for CT reconstruction.

The CT reconstruction assumes a linear relationship between the attenuation properties of different materials (i.e. multi-material objects), which does not exist at lower energies due to the different photon interaction

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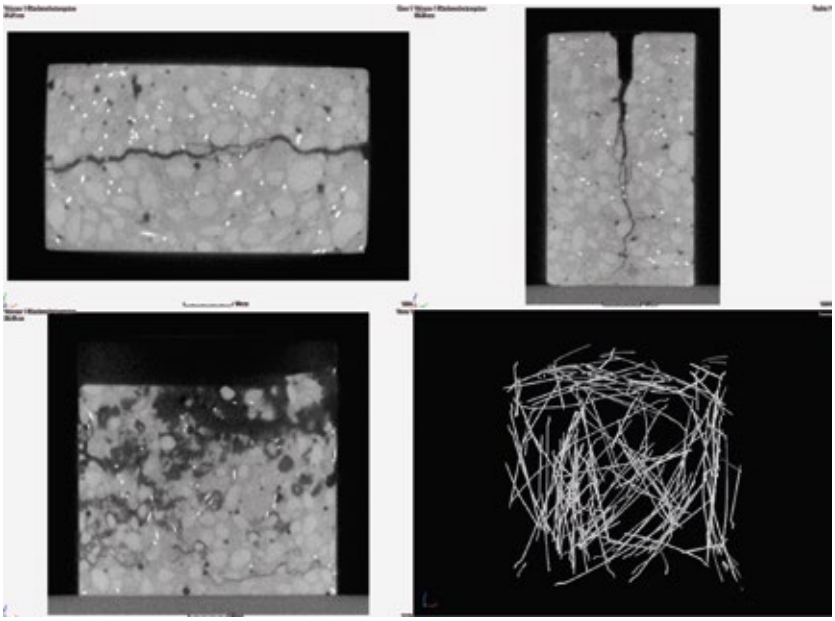

Fig. 3: Even in solid concrete samples, the steel reinforcement can be shown simultaneously with the finest cracks.

> *The combination of high penetration length and high spatial resolution makes it an ideal method for analyzing materials, whose „damage characteristics“ can be traced to local fine structures, such as weld seam defects.”*

effects. In conventional CT, these multi-material artefacts which are often described as „overexposure“ or black holes“, cannot be avoided. Figure 2 shows the difference between a 450 keV and 9 MeV scan. In contrast to the 9 MeV scan, the image of the aluminum cylinder head is strongly distorted by the steel screw.

In this instance, high energy CT offers a major advantage compared to conventional CT, even for components with compact dimensions, which originally would not need high energy irradiation. This applies even more for compact high density objects, such as engine components made from platinum, nickel or tungsten as well as objects with poor absorption, such as reinforced carbon fiber composite materials with metal inlays.

As shown in figure 3, even in solid concrete samples, steel reinforcements and the finest cracks can be shown simultaneously with sufficient contrast.

Implementation of an XXL-CT System

The system shown below (fig. 4) has two different detectors: a flat panel detector with a field of view of 38 × 38 cm and a pixel size of 100 µm, and a 4 m-long and 400 µm pixelated X-ray line detector, which makes it possible to inspect entire vehicles. Depending on the application, either of the detectors may be used; the flat panel detector offers a short scan time, since the two-dimensional image is captured directly and only a single rotation of the test part is necessary to capture a 3D volume. For large scale objects of high absorption and long penetration lengths a line-by-line capture is preferred. The one-dimensional detector type allows collimating the irradiated object down to the size of the detector field and leads to a dramatically reduced scattered radiation. This so called fan-beam geometry is applied onto the whole object by elevating the source and detector.

As well as the radiation source and the detector, the manipulation system and measuring methods play an important role. The thorough and complete investigation of large and solid components, such as entire cars, thus becomes possible and industrially applicable for the first time. The XXL-CT is capable of scanning objects with a weight of up to 10 t at a maximum voxel size of 333 microns, for smaller and lighter objects with same demands on penetration but even higher demands on resolution and shorter scan duration a second manipulation system is installed, comparable to conventional CT systems in terms of accuracy and object sizes. Combining it with the linear accelerator

▶ **Fig. 4: Interior of the high energy test facility. The radiation source and detector can travel at height by means of a tower system, in order to scan large objects and generate projection images of up to 4.6 x 4 m (height x width) with a 400 µm sampling distance.**

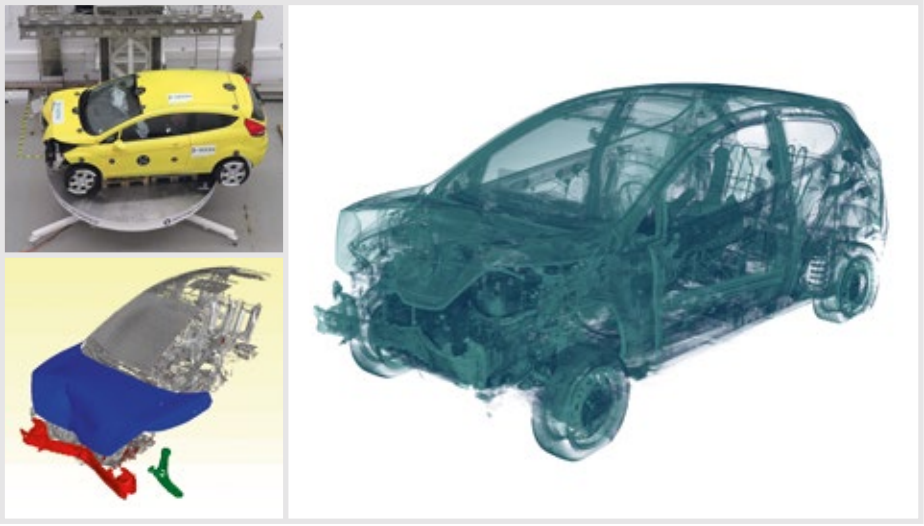

Fig. 5: CT scan of a crash vehicle (top left), 3D rendering (right) and extraction of deformed areas (bottom left).

allows to fill the gap between conventional CT and the large scale XXL-CT and to cover the widest range of CT applications today.

From the deformation analysis after a crash test on a full vehicle or its subparts or for dimensional measuring of fully-assembled electric power trains to the documentation of a prototype vehicle after test phases and manual optimization, the applications are unlimited.

Currently, such examinations are made by destructive methods, in particular for internal structures, by sawing up or manually dismantling the vehicle. Representative parts in the interior can then be inspected and their condition documented. With this method, structural changes to the components under investigation cannot be avoided, which is why non-contact, non-destructive test procedures offer a huge added-value. Because a high resolution of approximately 333 µm for a large scaled object can be achieved, the state of deformation, for example on the crash-damaged areas on a vehicle, can be recorded without the costly preparations. Imaging the structures as a volume or surface mesh in a three-dimensional coordinate system makes it possible to record precise measurement values. Depending on the object to be measured, it is currently feasible to achieve a longitudinal measurement accuracy of up to +/-700 µm over a length of approximately 3 m. Thanks to the contrast sensitivity of the measurement system, defects such as blowholes or cracks can be detected additionally. Figure 5 shows how the data can be post-processed. Individual components can be segmented out of the overall assembly and converted to surface data formats, in order, to carry out geometry comparisons (variance analysis) with construction data (CAD data) or compare the deformation caused by the crash with results from finite element simulations. As well as the considerably greater capacity for high penetration lengths, compared to low radiation energies, the possibility of producing equally good imaging results for materials with both high and low absorption characteristics is a further advantage of high energy X-ray processes. This is achieved due to the already mentioned high signal linearity of very different materials in the energy range above 1 MeV and the reduced "beam hardening artefacts".

Figure 6 clearly shows the high quality of the scan of a car passenger safety cell with doors assembled and the combination of various materials, such as steel, glass and plastic. The scan time of the XXL-CT for a complete vehicle depends on the image quality required and varies from hours to several days. The reconstructed quantity of data is between 15 and 400 GB depending on the required spatial resolution.

Outlook

The great potential of the XXL-CT has already been shown for a wide range of different applications like the (crash-) car analysis. The focus of development is to further industrialize the technology by optimizing the scanning process, i.e. reducing measurement time, increasing image quality and to make the mass of resulting data easier accessible to the end-user. This could be for example the extraction of the pure deformation of a specific part out of the CT data set of a crashed car. This involves efficient handling of big data sets of a few hundred GBs but also automated algorithms to – in this case – find and extract the part and convert it to a mesh-based file format.

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Fig. 6: CT sectional image through the passenger safety cell (left) and enlarged image of the door area (right).

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Dedication to High Speed

High-Speed Thermal Imaging for Automation Applications

Thermal imaging cameras have been engineers' means of choice for non-contact measurement in a variety of automation applications in recent years. Some high-speed automation applications require dedicated, advanced thermal cameras to ensure precise measurement.

For many years, thermal imaging cameras have found their way onto the factory floor. Manufacturing and process engineering specialists have used thermal imaging cameras with great success for practically any automation application, including automated inspection, process control, condition monitoring, fire prevention and detection, and continuous optical gas imaging. However, not all automation cameras are created equal and for some high-speed automation applications dedicated, advanced thermal cameras are required.

Frequently, manufacturing and process engineers use automation techniques to improve throughput and product quality. Automated thermal imaging offers the potential for improving a host of industrial production applications, including process monitoring and control, quality assurance, asset management, and machine condition monitoring.

Thermal Imaging in an Automation Environment

Thermal imaging cameras use thermal radiation, which is not detectable by the human eye, but can be converted into a visual image that depicts thermal variations across an object or scene. Covering a part of the electromagnetic spectrum, thermal energy is emitted by all objects at temperatures above absolute zero, and the amount of radiation increases with temperature. A thermal imaging or infrared (IR) camera can capture thermal images of target objects and provide accurate non-contact temperature measurements. These quantitative measurements can be used in a variety of monitoring and control applications.

In some cases, a thermal camera is referred to as a smart sensor. In these cases the thermal camera has built-in logic and analytics that allows the comparison of measured temperatures with user-supplied temperature data. It also has a digital I/O interface so that a differential temperature can be used for alarm and control functions.

Cooled and Uncooled Cameras

There is plenty of choice when it comes to thermal imaging camera systems for automation applications. An often asked question is therefore: "Should I use a cooled or an uncooled thermal imaging system and which one is the most cost effective?"

In fact, there are two classes of thermal imaging camera systems available on the market today: cooled and uncooled systems. The component costs for these two classes of systems can be quite different, making it extremely important to decide which way to go.

Cooled Thermal Imaging Cameras

A modern cooled thermal imaging camera has an imaging sensor that is integrated with

Flir A66xx compact, thermal imaging camera with cooled InSb detector.

a cryocooler. This is a device that lowers the sensor temperature to cryogenic temperatures. This reduction in sensor temperature is necessary to reduce thermally-induced noise to a level below that of the signal from the scene being imaged. Cryocoolers have moving parts made to extremely close mechanical tolerances that wear out over time, as well as helium gas that slowly works its way past gas seals.

Cooled thermal imaging cameras are the most sensitive type of cameras and can detect the smallest of temperature differences between objects. They can be produced to image in the mid-wave infrared or MWIR band of the spectrum where the thermal contrast is high due to blackbody physics. Thermal contrast is the change in signal for a change in target temperature. The higher the thermal contrast, the easier it is to detect objects against a background that may not be much colder or hotter than the object.

Uncooled Thermal Imaging Cameras

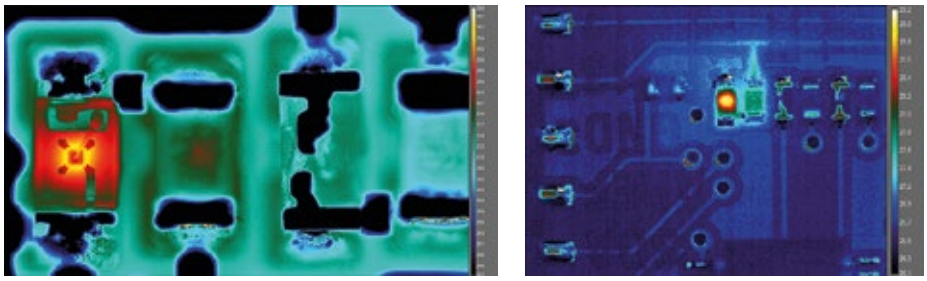
An uncooled infrared camera is one in which the imaging sensor does not require cryogenic cooling. A common detector design is based on the microbolometer, a tiny vanadium oxide resistor with a large temperature coefficient on a silicon element with large surface area, low heat capacity and good thermal isolation. Changes in scene temperature cause changes in the bolometer temperature which are converted to electrical signals and processed into an image. Uncooled sensors are designed to work in the Longwave infrared or LWIR band, where terrestrial temperature targets emit most of their infrared energy.

Uncooled cameras are generally much less expensive than cooled infrared cameras. The sensors can be manufactured in fewer steps with higher yields relative to cooled sensors, less expensive vacuum packaging, and uncooled cameras do not require cryocoolers, which are very costly devices. Uncooled cameras have fewer moving parts and tend to have much longer service lives than cooled cameras under similar operating conditions.

Cooled Cameras for Automation Applications

Advantages of uncooled cameras beg the question: When is it better to use cooled thermal imaging cameras for automation applications? The answer is: it depends on the application.

If you want to see the minute temperature differences, need the best image quality, have fast/high speed applications, if you need to see the thermal profile or measure the temperature of a very small target, if you want to visualize thermal objects in a very specific part of the electromagnetic spectrum, or if you want to synchronize your thermal imaging camera with other measuring devices, then a cooled thermal imaging camera is the instrument of choice.



The thermal images compare the best close-up magnification that can be achieved with a cooled and uncooled camera system. The image on the left was taken with a 4× close-up lens and 13 µm pitch cooled camera combination resulting in a 3.5 µm spot size. The image on the right was taken with a 1× close-up lens and 25 µm pitch uncooled sensor resulting in a 25 µm spot size.

> *"Advantages of uncooled cameras beg the question: When is it better to use cooled thermal imaging cameras for automation applications? The answer is: it depends on the application."*

Speed

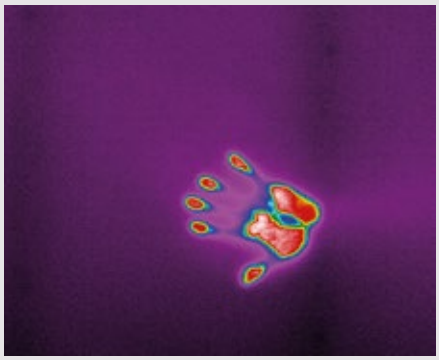
Cooled cameras have much higher imaging speeds than uncooled ones. Automation cameras like Flir's A66xx series can have image speeds of up to 480 frames per second and therefore they are ideal for capturing high-speed thermal events and moving targets. This can be interesting for example when manufacturing quality of high-speed conveyor belt applications needs to be monitored. The capture rate of uncooled thermal imaging cameras is simply too slow to capture the speed of some conveyor belt applications.

Cooled cameras have very fast response times and they make use of a global shutter. This means that they will read out all pixels at the same time, as opposed to reading them out line by line, which is the case with uncooled cameras. This allows cooled cameras to handle moving objects much better. This is especially important in the process industry like paper processing, or in high-volume manufacturing, where things move fast and cannot be slowed down. Cooled cameras will also accurately monitor fast changes in heat-up processes.

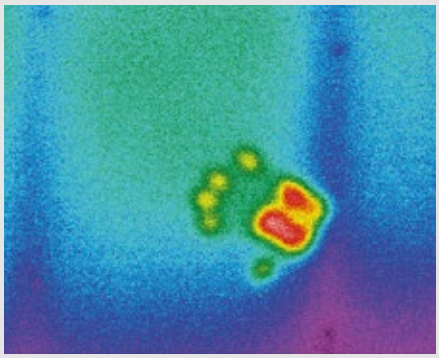
Spatial Resolution

Cooled cameras typically have greater magnification capabilities than uncooled cameras, because they sense shorter infrared

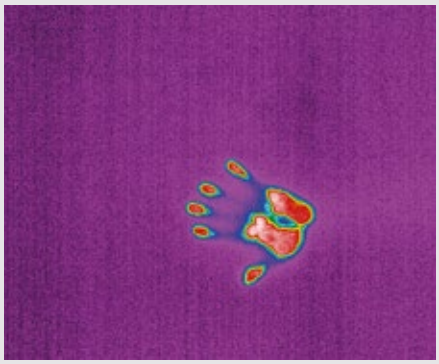
Continued on page 50



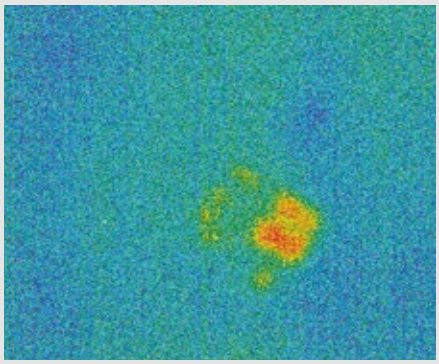
Cooled thermal camera image of handprint on wall initial image.



Cooled thermal camera image of handprint on wall after 2 minutes.



Uncooled thermal camera image of handprint on wall initial image.



Uncooled thermal camera image of handprint on wall after 2 minutes.

wavelengths. Because cooled cameras have greater sensitivity characteristics, lenses with more optical elements or thicker elements can be used without degrading the signal to noise ratio allowing for better magnification performance.

Sensitivity

How do you get a feeling of the benefit from a 50 mK sensitivity uncooled thermal camera in comparison to a 20 mK sensitivity cooled thermal camera? Let's illustrate this with a quick sensitivity experiment.

For this comparison we put our hand on a wall for a brief few seconds to create a thermal handprint. The first two images show the handprint immediately after the hand was removed. And the second set of images shows the thermal handprint's signature after two minutes. The cooled camera can still see most of the thermal signature of the handprint, whereas the uncooled camera only shows the partial remains of the handprint. The cooled camera clearly can detect smaller temperature differences and for longer durations than the uncooled camera. This means the cooled camera will provide better detail on your target and help you detect even the faintest of thermal anomalies.

Spectral Filtering

One of the great advantages of cooled thermal cameras is the ability to easily perform spectral filtering in order to uncover details and take measurements that otherwise would be unachievable with uncooled thermal cameras. You could use cooled cameras to look through glass or to spot dangerous gases like Benzene, Ethanol, Methanol and Octane in gas installations that are in remote areas or in zones that are difficult to access. Another possible application is the quality monitoring of a plastic calendaring process.

Synchronization

Precise camera synchronization and triggering makes the cameras ideal for high-speed, high-sensitivity applications. Working in snapshot mode the Flir A66xx is able to register all pixels from a thermal event simultaneously. This is particularly important when monitoring fast moving objects where a standard IR camera would suffer from image blur.

For example, if you drop a coin and have a sensor trigger the camera to take an image. Two drops of the same coin will trigger the camera at the same time giving you the object in the same position every time. With a microbolometer you would not catch the coin at all and if you did by luck it would be blurry, positioned anywhere in the image.

Compact, Thermal Imaging Camera with Cooled InSb Detector

Flir offers a solution for practically any automation application from uncooled, low-cost cameras to high-end thermal cameras. The Flir A66xx is ideal for high-speed thermal events and moving targets, and it incorporates a cooled Indium Antimonide (InSb) detector. The camera produces crisp thermal images of 640 x 512 and achieves a high thermal sensitivity of < 20 mK. The camera is able to capture very fine image details and temperature difference information. It supports image frame rates up to 480 frames per second when operating in windowing mode. Custom cold filtering options for specific spectral detection and measurement are available. Ideal for imaging through glass, measuring temperature of thin film plastics, filtering different wavebands for laser profiling and detection, or optical gas imaging.

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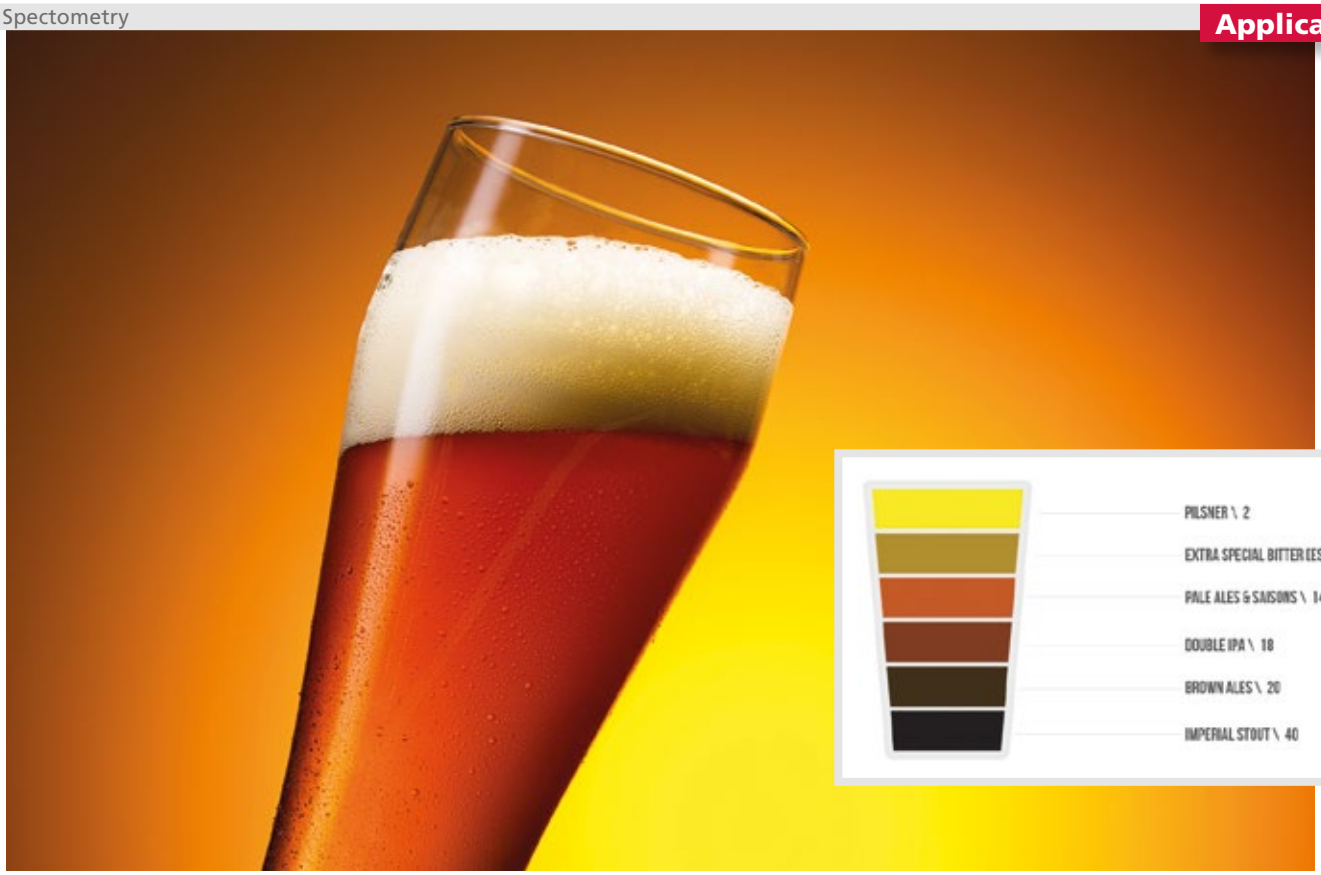
Application



Measuring Beer Color

Using Color Measurement in Control Processes to Verify Beer Types

Color measurement is a quality control process in which a highly sensitive spectrometer generates a quantitative spectrum across ultraviolet and visible wavelengths. This is a well-known process in the paint, food, and textile industries used to ensure accurate results and reduce observer perception error.

Because beer color is a quantifiable characteristic that helps identify ingredients and processes, the American Society of Brewing Chemists (ASBC) used it to create a reliable, accurate method to verify its consistency across different beer batches. Their Standard Reference Method (SRM) quantifies beer color by measuring absorption of attenuated light at 430 nm wavelength passing through 1 cm^3 of beer. Absorption is then multiplied with the SRM constant 12.7 to find the beer's SRM number on a 2 to 40+ scale, with higher numbers indicating darker beers.

It is necessary to obtain original SRM color data using spectrometers in transmission mode, which relies heavily on correct sample placement and geometry to achieve desirable accuracy. But to verify SRM numbers, reflection mode is a viable alternative that enables verification without the meticulous lab setup transmission mode requires. A white LED light is pointed at the beer sample, and the light reflected from the sample hits the spectrometer.

Anshuman Das at the MIT Media Lab and Tata Center for Technology and Design created a wireless process to detect beer type by using the C12666MA micro-spectrometer in reflection mode and sending the data to his mobile app called Biiru.

The beer is set on chrome-plated polished bases. A light source is set above the sample. The spectrometer generates an analog signal, which is converted into digital by the Arduino and Bluetooth board built by Das. The Biiru app wirelessly receives this data and creates a traditional spectrum. In reflection geometry, the micro-spectrometer captures the sample's spectrum and looks at the ratios of blues, greens and reds. It measures intensities at 438, 500, 530, 535, 560, 580, and 600 nm wavelengths. The ratios of all these wavelengths with each other, I(438)/I(500), I(438)/I(530), etc., yield an array of 21 combinations on the app.

The app compares the unknown beer to a spectral library of known SRM data. The closest beer match is calculated when the spectrum feeds into the wavelength ratio algorithm:

$$\begin{matrix} Avg(|[Ratio(Unknown)] - [Ratio(Known\ Beer\ 1)]|) \\ \vdots \\ Avg(|[Ratio(Unknown)] - [Ratio(Known\ Beer\ N)]|) \end{matrix}$$

This operation produces a single array of differences for each beer comparison. The app software takes the mean of each array, with the smallest difference indicating the closest match. For example, if the difference between the mean of the unknown sample is 1.4 for Bud Light and 0.01 for Sam Adams Boston Lager, then the app will identify the sample as Sam Adams.

Smaller and more portable technology not only creates easier ways to perform established applications, it also encourages the development of new ones like this demo or quickly and accurately testing fruit ripeness.

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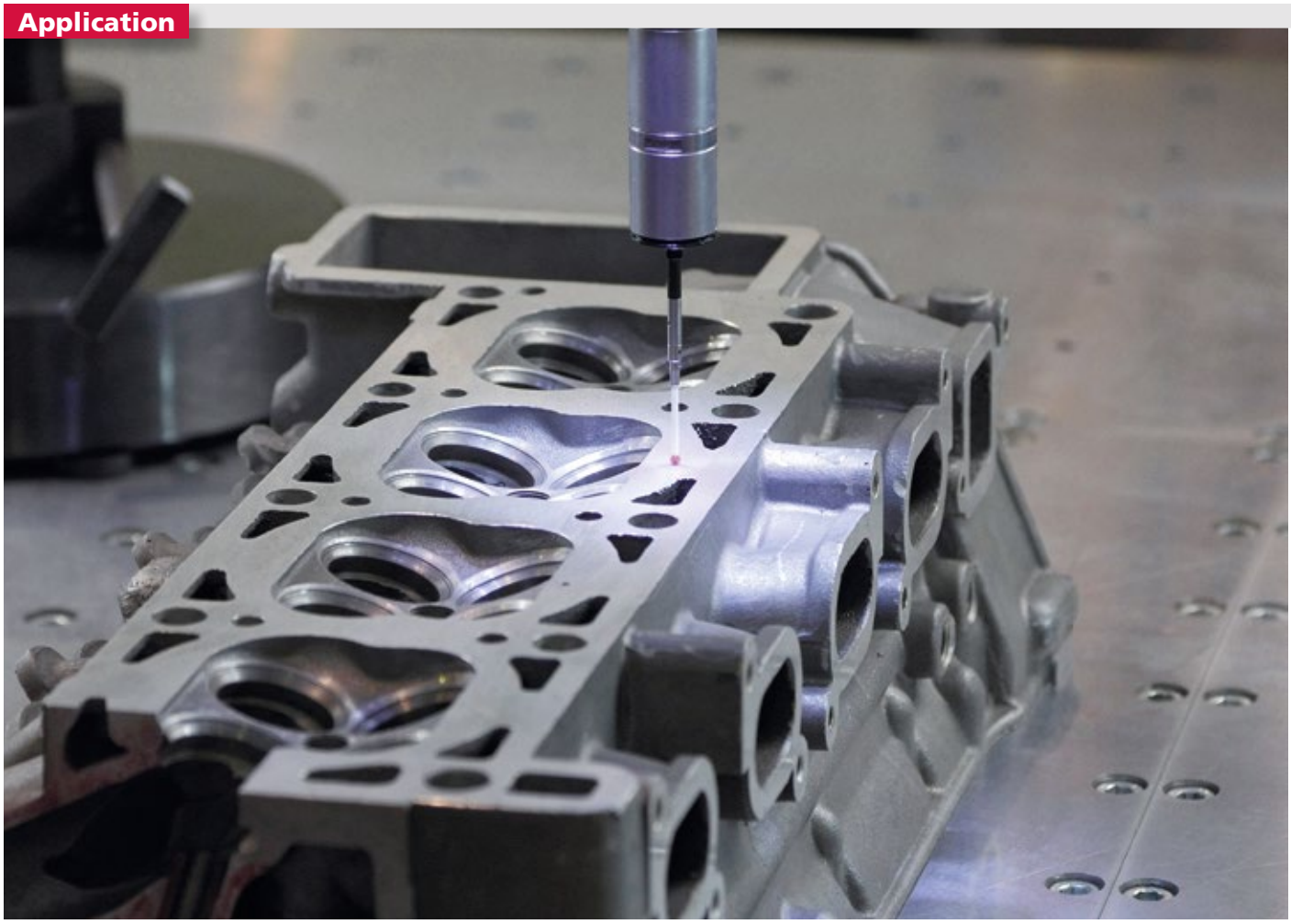
http://www.hamamatsu.com/eu/en/community/optical_sensors/articles/measuring_beer_color_with_microspectrometer/index.html



A Guide to Industrial Metrologists

How the Manufacturing Industry Can Increase Productivity with Automated Quality Control

In quality control, both handling and measurement performance time are higher when using traditional equipment, which increases the time to market. Automated quality control solutions help to overcome the problem.

Traditional Metrology consumes a considerable amount of time and effort. Because traditional equipment is not located on the production floor, workers must move components to the measuring room to carry out inspections. The time required to perform the measurement, which is usually slower on traditional equipment, must also be added to the handling time. All this time allocated for quality control with traditional metrology increases production costs and go-to-market time[1]. Additionally, there is a significant lack of skilled human resources who can operate traditional equipment and control manufactured parts, the designs, and shapes of which are becoming increasingly complex with free forms and various finishes. In a context where the manufacturing industry faces pressure to tighten production costs, it is interesting to question traditional metrology. In fact, why use traditional equipment, such as the coordinate measuring machine (CMM), which is not only slow, but sometimes too accurate for the manufacturing requirements?

Challenges

In a metrology lab, it is common to see bottlenecks at various traditional measurement stations, which slows down the inspection rate. This turnaround time has negative consequences on factory productivity. Indeed, because of the lack of availability of CMMs, the sampling of inspected parts must be limited. Not only is the CMM difficult to access and slow to operate, but it must also be handled by qualified employees, who are rare to find in today's job market.

In manufacturing, where the slightest deviation of a few millimeters can have significant repercussions, every angle should be inspected, every thickness should be measured, and every hole and point of attachment should be checked. An unobserved defect will automatically result in lost productivity and increased production costs. For example, a survey of auto industry manufacturing executives shows stopped production costs an average of US$ 22,000 per minute[2].

The main challenge continues to be the ability to detect manufacturing problems sooner, i.e., as soon as they occur. To do so, part inspection must follow production rates, which requires reliable technologies that can keep pace and qualified human resources that can operate the equipment. How can companies detect flaws if, on the one hand, the CMM is overloaded and, on the other hand, specialized operators are rare?

Solutions

To detect flaws as quickly as possible without moving parts to a metrology lab, companies need to be able to conduct the inspections right on, or very near, the production line. This requires reliable systems capable of

An automated quality control solution using optical reflectors to carry out accurate and repeatable measurements on the shop floor.

measuring in an industrial environment. The suitable solution must, therefore, be insensitive to the instabilities of a production floor such as permanent vibrations and constant temperature and humidity fluctuations. The need to perform dimensional inspections within the production cycle drives the development of automated metrology solutions.

Where the CMM is a metrology tool, an automated quality control (AQC) solution is an industrial tool, perfectly adapted to the instabilities of a manufacturing environment. From computer equipment to the robotic grade of cabling, every element of an automated quality control solution is chosen based on its robustness, reliability, and ease of use.

Metrology inspection carried out on traditional equipment in the measuring room.

Automated quality control solutions prioritize, among other things, the use of optical reflectors that allows dynamic referencing of parts and the use of 3D scanners that ensure accurate and repeatable measurement on the shop floor. Moreover, the use of laser scanners and improved laser detection algorithms enables the measurement of various shapes, sizes, and finishes, which is mandatory since manufactured parts now have more and more complex geometries.

Since the operators who handle these industrial solutions are people from the production department – not people from the quality control department – automated quality control solutions must be as simple and friendly as any other machines and tools on the production line. Therefore, it makes them user-independent solutions that can be used by any type of operator, regardless of skill levels and qualifications.

Finally, certain product development phases, such as pre-production, assembly of first prototypes, or first article inspection, have larger inspection requirements. Thanks to the synergy of hardware and software, automated quality control solutions are not only simple to use; they are also simple to implement. Therefore, they have the flexibility to adapt to problems of the current moment and thus allow, for example, for a reprograming or a new inspection faster than with a CMM.

Results

Automated quality control solutions help increase productivity because they allow for more inspections per hour, which has an impact on production costs. Indeed, production costs depend mainly on the cost of used or discarded raw material. The more raw material is thrown away, the higher the production costs. Problems can be detected earlier when more quality controls are performed per hour, thus fewer faulty parts are made, fewer replacement parts are needed, and less material is thrown away.

> *“Where the CMM is a metrology tool, an automated quality control (AQC) solution is an industrial tool, perfectly adapted to the instabilities of a manufacturing environment.”*

Not only are problems, defects, and irregularities detected earlier, but also equipment maintenance and corrective actions in the manufacturing process can be identified and planned in advance. In short, the number of default parts that must be rebuilt decreases, the rate of discarded pieces compared to manufactured parts decreases, and more parts are manufactured and sold with the same amount of raw material. Productivity increases as well as the quality of manufactured products.

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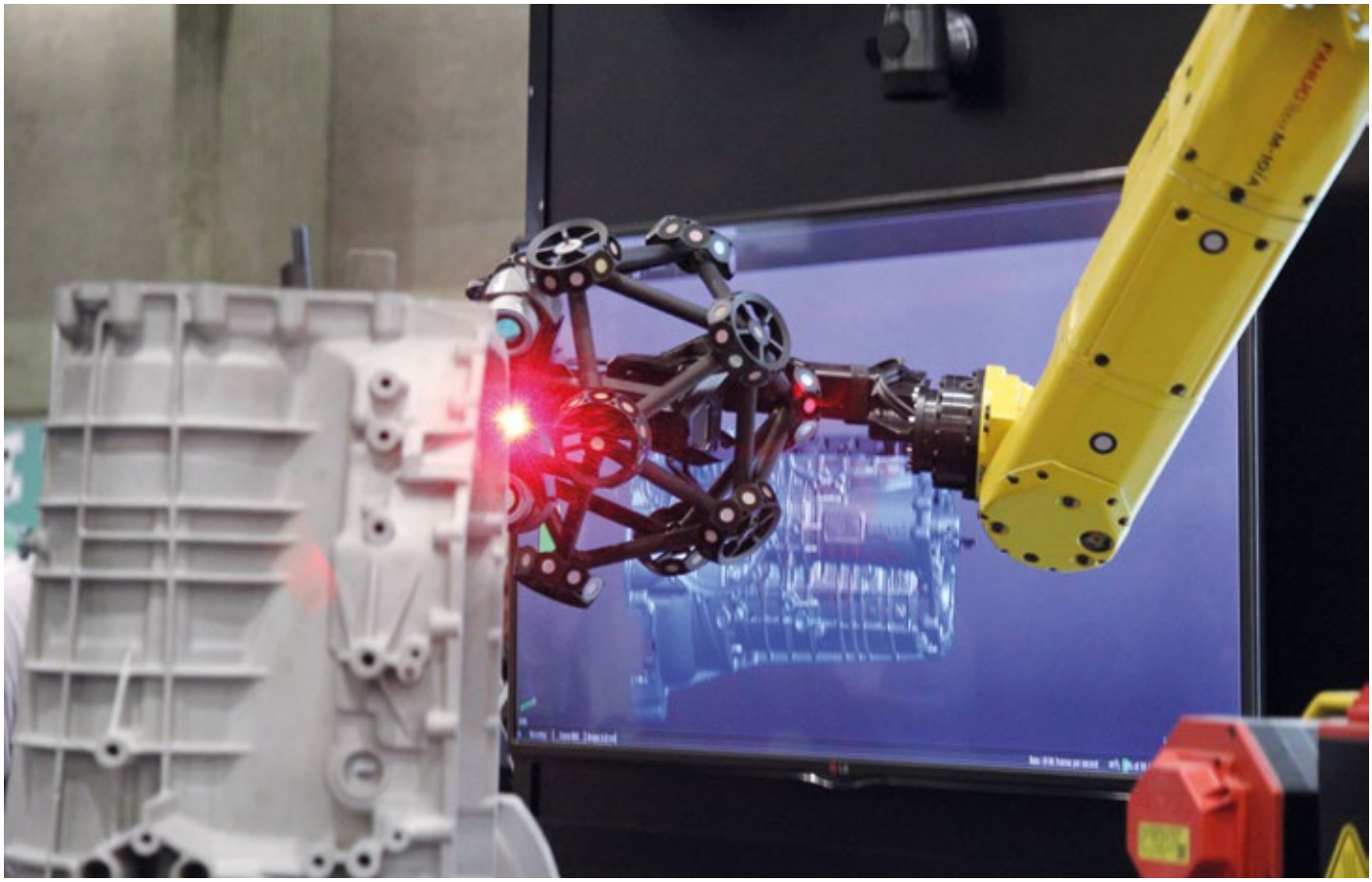

MetraScan 3D-R Series: Automated quality control solution suitable for near-line inspection.

> *"Automated Quality Control solutions help increase productivity by allowing more inspections per hour."*

Lower Cost, Higher Productivity

The reduction of production costs, which is a priority for a large number of players in the manufacturing industry, involves increasing productivity (i.e., producing more by throwing away less) while guaranteeing product quality. Thus, the more flaws are detected early in the manufacturing process, the less expensive those flaws will be in terms of corrective actions.

The ability to promptly inspect parts is not only used to quickly manufacture and deliver the goods; it also helps to track manufacturing trends in real time and detect future defects to predict corrective actions before problems occur. Thus, manufactured parts that are compliant with requirements and good quality ensures that no part is rejected. In other words, manufacturing companies have the opportunity to transpose quality control (ensuring the quality of finished products) into quality assurance (focusing on the prevention of processes and problems).

Eventually, some industry leaders will aim for the inspection of 100 % of the parts on 100 % of the dimensions. Indeed, it will be common in the future for manufacturing companies to inspect all manufactured parts before shipping because their customers will require access to inspection data before acknowledging receipt of ordered parts. This need for traceability for each produced part requires a quality system that allows for more inspections per hour in order to follow the production rate, where the measurement throughput matches the production throughput.

Automated quality control solutions located right on, or very near, the production line gives manufacturing companies the opportunity not only to increase their productivity but also to have revenues recognized faster while optimizing their manufacturing process.

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Covering All the Bases

Selecting the Most Suitable Technique for Coating Inspections

Coating inspection is an important aspect of quality control in many components and finished products. With the wide variety of techniques available for inspection, it is important to ask the question: what is really needed – resolution, speed, accuracy, all of the above?

Whether a coating is used as a protective barrier or merely for decoration – coating quality matters. When coatings protect the underlying material against air or moisture, it is often the thickness of the coating that determines its efficacy and longevity. Also, the presence of flaws plays a key role in coating quality. When it comes to inspection, the vast range of coating options has meant that there are several inspection techniques, which are well suited for coating inspection. Choosing the best method depends strongly on the type of coating – and on which benefits are most important for the task at hand. Let us take a closer look at the available options, helping you to make informed decisions and choose an inspection technology that fits your workflow.

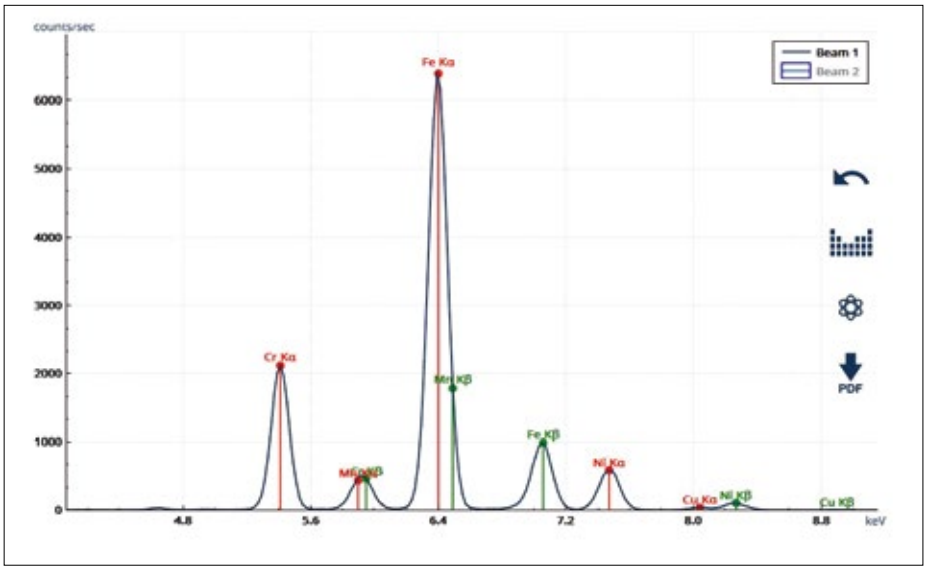
See for Yourself

If seeing all the ins and outs of a component or sample with high-resolution images is essential, microscopy is the technique to go for. Microscopy is an extremely versatile technique and different microscopes offer different benefits for quality control of coatings.

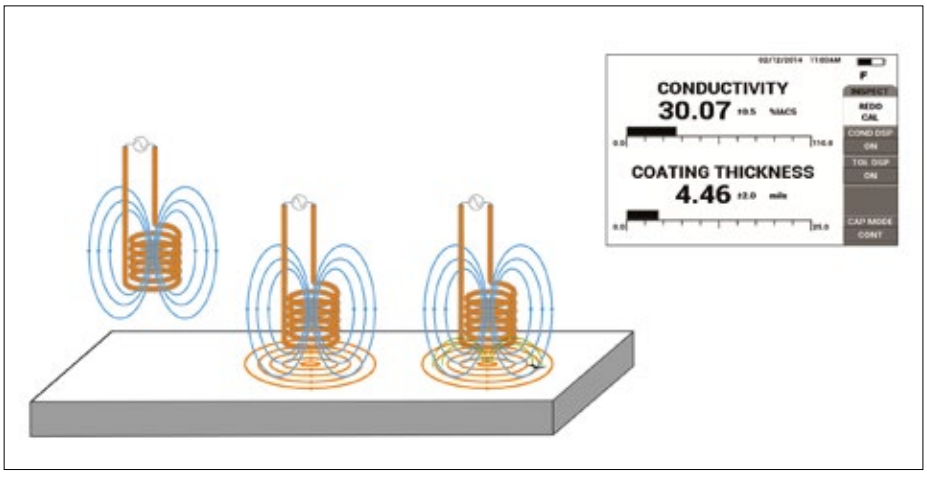
When using an industrial light microscope, samples can be inspected in great detail – not just for measuring the thickness of the coating, but also for looking at flaws, irregularities and

Continued on page 56

for assessing the bond between the coating and the underlying material. Images are easy to interpret and there is no limit to the number of layers that can be distinguished. The main drawback, however, is that light microscopy is a destructive technique, which usually means that a component (or a part of it) has to be cut to reveal a cross section. After cutting, a sample also needs to be prepared for microscopy by grinding and polishing in order to produce a clean, detailed image.



An XRF spectrum shows the presence of metals in a sample, which can be used to determine coating thickness.



During an eddy current inspection, coatings can be measured by using the electric currents that are generated inside the component.

Inspecting PCBs

The level of detail shown by polished cross section imaging is highly beneficial in the inspection of printed circuit boards (PCBs). In PCBs, a complex internal structure of resin and copper coatings can be visualised with great precision with light microscopy. Confocal microscopy can serve as an alternative to destructive cross section-based testing. When a coating is transparent, confocal microscopes can provide precise details of either one or multiple layers of coating with minimal sample preparation. Its pinhole-based setup eliminates out-of-focus light, enabling sub-micrometre precision. For larger components, confocal microscopes with an extension frame, such as the Olympus Lext OLS5000, are suitable as these can accommodate samples of all shapes and sizes.

Down to the Nano-Scale

When detection of very thin coatings, such as those below 100 nm, is required, elemental analysis is a suitable option. Elemental analysis can be carried out using X-ray fluorescence (XRF) detectors. Although this technique comes with constraints on which elements can be detected, XRF spectra show extremely small traces of most metals, which correlate well with coating thickness. For fast elemental analyses that can be done on the factory floor rather than in a testing lab, portable handheld XRF analysers, such as Olympus' Vanta series, can be used. XRF analysers can give coating thicknesses within seconds, thereby causing minimal disruption to the production workflow. As a fast method for detecting metal-containing coatings with high precision, one application where XRF is particularly well suited is galvanisation inspection. Galvanised products usually consist of a zinc coating that is covering a component, which does not contain zinc. This means that the zinc signal in the XRF spectrum is a reliable indicator of coating thickness.

Multi-Tasking with Eddy Currents

The easiest way of adding coating measurements to an inspection workflow is to carry out the measurement with the equipment that is already part of the inspection process. Eddy current flaw detection for example, is a technology that is frequently used in the

> *"The potential for inspecting large areas in less time makes ultrasound a frequently used technique in pipeline inspections."*

The extension frame of the Olympus Lext OLS5000 enables detailed inspection of samples of up to 21 cm in height.

aerospace industry to inspect different components of an aircraft. However, the same equipment can also be used to measure the thicknesses of non-ferromagnetic coatings with high precision. Eddy current flaw detectors generate an electric field that produces detectable currents in the bulk material. These currents give information about flaws inside the material – and also about the properties of the coating. Aside from the obvious cost savings, carrying out coating inspections with already purchased equipment also means that less training is required.

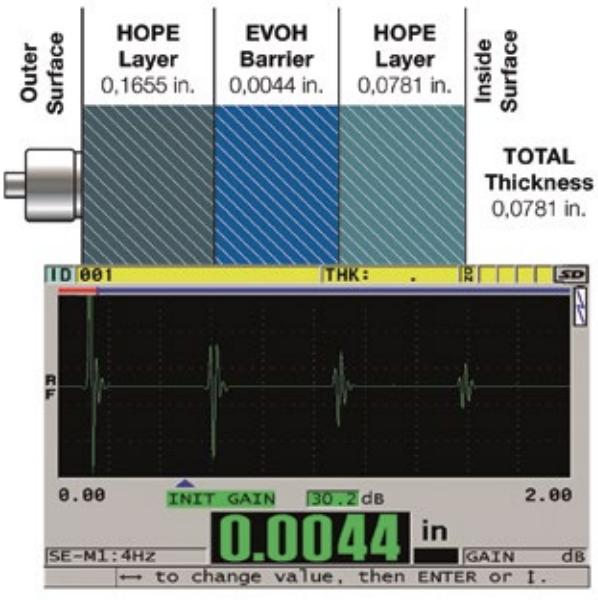
Furthermore, carrying out two different inspections using the same piece of equipment also saves time and makes the inspection easier.

Large Areas, High Throughput

In the inspection of large surface areas, the speed of the inspection is often a critical parameter. For this type of inspection, ultrasound technology is a commonly used technique. Ultrasound works by sending high-frequency sound waves through the component that needs to be inspected. These sound waves can travel relatively unhindered through solid material but will deflect off any kind of interface within the material. This property makes ultrasound suitable for inspections such as corrosion monitoring, but it also makes it easy to check the thickness of a coating. The potential for inspecting large areas in less time makes ultrasound a frequently used technique in pipeline inspections. Pipelines can be coated with a corrosion-resistant alloy that serves as a protective barrier against moisture and air.

Save Time and Costs

In industrial inspection and quality control, coating measurements are an important indicator of the quality and longevity of a product. A range of different technologies can be used – each offering distinct benefits, such as speed, resolution, ease of use or a dual functionality. Microscopy, X-ray fluorescence, ultrasonic flaw detection and eddy current flaw detection enable you to measure the thickness of a coating as well as other coating properties. Choosing the most suitable technique for your inspection can help to save time, save costs and get the utmost precision in the parameters you need to make informed decisions on safety and quality.



Scan of a metal component that has been coated with a corrosion-resistant alloy. The scan was created by conventional ultrasound using Olympus' 45MG thickness gauge.

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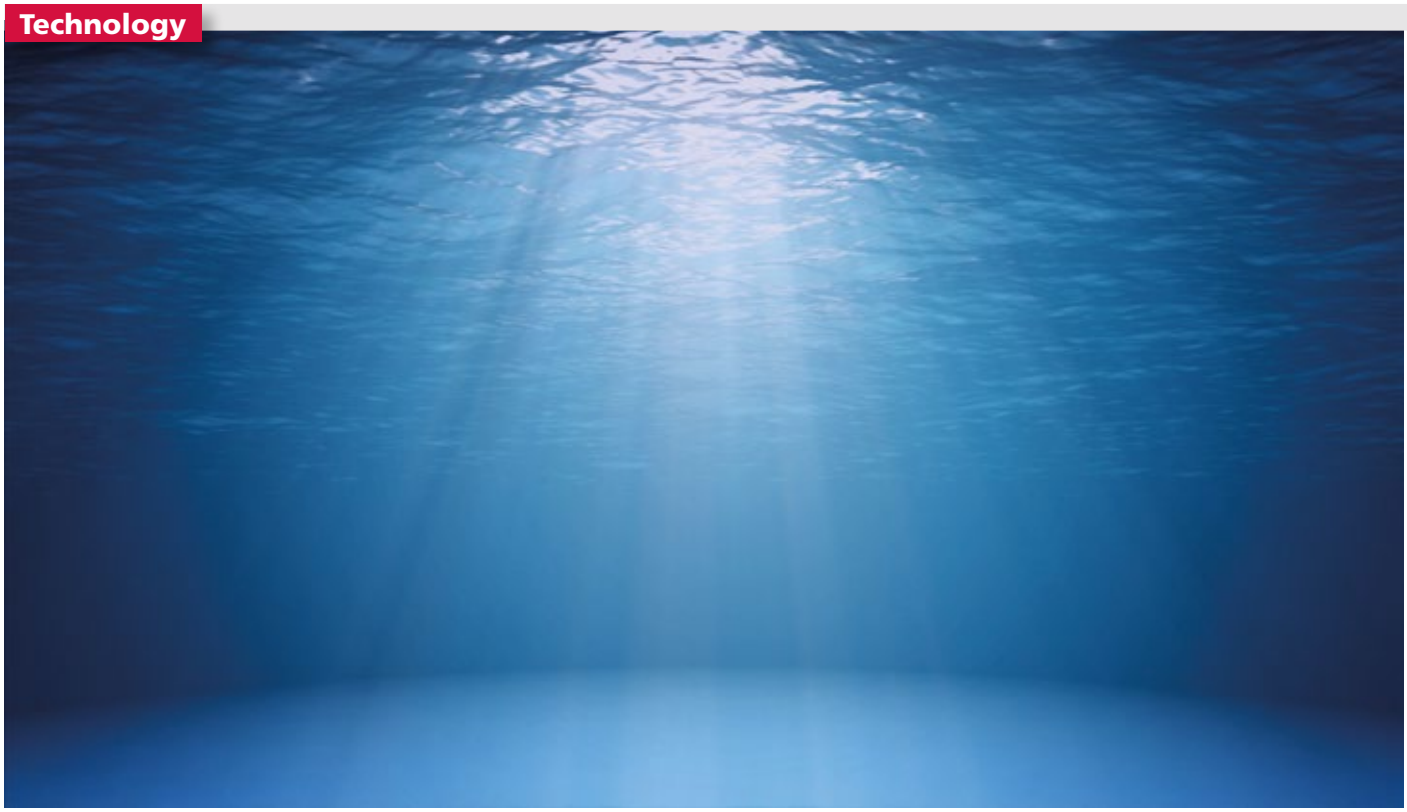

From Surfaces to Deep Depths

Line Confocal Technology in Challenging 3D and 2D Imaging Applications

Line confocal sensors and scanners based on them, can be used in 3D imaging of surfaces, transparent materials and multi-layered structures in various metrology and inspection applications on parts, assemblies and continuous products.

In the late 2000's, researchers at Technical Research Center of Finland (VTT) invented a new optical method to image 3D microtopography of surfaces at sub-micron resolution. This method, named Line Confocal Imaging (LCI), is based on capturing a continuous line of light reflections in visible spectrum from more than 2000 lateral surface points simultaneously. In 2009, FocalSpec was founded as a spin-off from VTT to further develop and commercialize the LCI technology, and the first LCI sensors were installed in commercial applications a couple of years later.

Fig. 1: Line confocal imaging sensors.

Imaging results from line confocal sensors and scanners can be used to calculate a product's 3D form and dimensions; surface topography, roughness and texture; thickness, flatness, 3D volume, etc. An interesting additional feature of the LCI method is its capability to simultaneously acquire 2D gray-scale (intensity) images from the scanned surface with a large depth of focus that covers the sensor's entire z range, up to 5.50 mm.

Line Confocal Imaging

Figure 1 shows the LCI sensor models that are currently in production. Each sensor has two front lenses, one for its transmitter and another for the receiver. Figure 2 depicts an LCI sensor's imaging principle. The sensor's transmitter has a light source that emits white light containing all visible wavelengths. A complex optical assembly separates the light into wavelengths and focuses a horizontal line of each color at a different distance from the sensor, forming a focal plane. Depending on the vertical position of the imaged surface within the plane, corresponding wavelengths from 2048 lateral measurement points are reflected back to the sensor's receiver. The receiver's spectral camera captures wavelength and intensity information from each point and forms related height profile and intensity lines. When the surface moves in front of the sensor, a 3D point cloud and 2D gray-scale image are generated from the scanned surface line by line. The resulting data can be processed, analyzed and reported with various 3D surface analysis and image processing software packages.

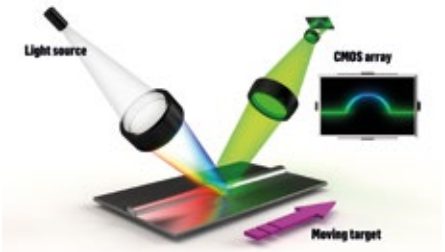

Fig. 2: Line confocal imaging principle.

Depending on the imaged material, surface type and resolution requirements, three

sensor models have been made available. The sensor with highest resolution offers vertical (z) resolution of 100 nm and z range of 1.00 mm. The next model up in size has z range of 2.80 mm and z resolution of 0.55 µm. The largest model has z range of 5.50 mm and z resolution of 0.98 µm. Lateral resolution in measurement line direction (x) varies from 2.20 to 8.00 µm, depending on the sensor model. Y resolution depends on line spacing which also affects the maximum surface motion speed in the application. The length of the sensors' measurement line is from 4.50 to 16.40 mm. The sensors can be integrated in both off-line and real-time in-production metrology systems as they can operate at the speed of up to 4,000 lines per second. This results in data acquisition rate of over 8 million 3D surface points per second. 2D intensity image data, potentially from several vertical layers or interfaces within the scanned area, can further increase this number.

Fig. 3: 3D line confocal scanner UULA.

Benefits of Line Confocal Imaging

LCI sensors and systems work well in applications that require high-speed imaging of challenging materials at sub-micron resolution. Scanning an area that would require tens of minutes for traditional 3D imaging methods, such as point confocal or interferometric technologies, can be now completed within a few seconds.

Materials with highly reflective, mirror-like, high-contrast or transparent surfaces are ideal for LCI. Perhaps surprisingly, the surface colour doesn't affect the results. Sensors' large numerical aperture and high tolerance for surface angle variation allow for imaging of steep mirrored slopes and glossy curved surfaces. LCI does not suffer from speckle effect; this enables surface imaging at higher resolution than laser triangulation sensors ever can.

The quality of raw data produced by LCI sensors is typically so good that it rarely needs filtering or other manipulation of any kind. Since the sensors capture 2,048 measurement points simultaneously, vibration of the imaged surface or the sensor itself seldom causes issues as relative point positions within the measurement line remain unaffected.

Applications

Most LCI sensors and systems are currently being used in research and development and quality control of manufactured parts, assemblies and continuous products. LCI can be used to image various materials including plastics, metals, glass, ceramics, composites, paper and wood.

Depth and shape of etched and embossed 3D features; texture and parting line flash of molded parts; roughness of extruded continuous products; and edge burr of micro-machined, precision-stamped and slit products can be imaged with LCI both in laboratory and production conditions in real-time. New promising applications for the method include medical and microfluidic devices that are often made from highly reflective materials, printed electronics with traces and other features printed on glossy transparent substrates; and glossy and transparent dispensed fluids, such as adhesive dots, lines and coatings.

Parts and assemblies used in consumer electronics products often contain highly reflective polymer, glass and metal surfaces that also can be measured and inspected with LCI sensors. One of the first applications utilizing deep depth of focus "tomographic" LCI imaging is inspection of heat seal completeness and integrity in sterile medical packages.

Sensor plus SDK

Bare LCI sensors can be integrated in custom systems for off-line and online metrology applications. A Software development kit (SDK) allows integrators to control sensor functions and read 3D profile and 2D intensity data as the specific application may require. The SDK includes an API, drivers and source code examples. The sensors connect to the outside world via an Ethernet port and both encoder and trigger inputs are supported. Sensors 24 VDC power supply is required for operation.

Line Confocal Laboratory Scanner

The FocalSpec UULA is a multi-purpose table-top surface metrology tool that can be equipped with any of the available LCI sensors. UULA's recipe-based and almost parameter-free operation is well suited for R&D and QA work that requires to quickly scan a variety and sometimes unknown surfaces. The scanner is equipped with an XY stage (size 222 x 310 mm), and an automated sensor height adjustment for taller parts and a rotary sample table are available as an option.

Inline Surface Roughness Measurement Systems

One application that greatly benefits from high-speed non-contact 3D surface imaging technology is inline surface roughness measurement. The MicroProfiler MP900 is designed to automatically measure and monitor surface roughness of fast-moving narrow products, such as wires, cables, tubing and extruded profiles. The system's maximum line speed is 150 m/min. The MP9000 on the other hand, is equipped with a traversing sensor mount. The system measures surface roughness of films, sheets and coatings across the width of narrow or wide webs. Other applications for the MP9000 include paper, foils and sheet metal. Both of the MicroProfiler systems monitor product surface continuously in real-time and they can be used to minimize the roughness or to keep it at a desired level.

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Dr. Klaus-Henning Noffz, Managing Director Silicon Software and Board Member of VDMA Machine Vision, responsible for standardizations

Setting New Standards

From May 14th to 18th, approximately 150 technical experts from all over the world will meet at the VDMA in Frankfurt, Germany, for the International Vision Standards Meeting (IVSM) hosted by Silicon Software, in cooperation with VDMA Machine Vision. The objective is to work on standards for machine vision and to discuss new standardization. The IVSM was founded by different Vision trade associations into a single trade body called "G3" with the goal to develop globally accepted standards and to prevent duplication of standardization efforts. We asked Dr. Klaus-Henning Noffz, who chaired the OPC UA working group, to give us deeper insight into the IVSM.

inspect: It has certainly been a challenge for standardization members to keep pace with the market requirements. This is even more valid today. If you draw from your wealth of experience and compare the lifespan of earlier "old" standards and current standards, what are the results?

Dr. Klaus-Henning Noffz: The lifetime of a standard is still very long. Camera Link, for example, was the first standard for image processing, and today it is still a very active standard. The reason for this lies in the fact that our customers build products with a typical lifespan of 15 years and therefore need long-term investment security. On the one hand, our market is conservative, and on the other hand our industry is also very dynamic. Camera manufacturers benefit from the immensely fast developing sensor market. Therefore, they always watch out for faster and improved interfaces. As time-to-market is critical and consumer interfaces develop rapidly, new standards need to be developed quickly.

Our industry can be proud as we can keep pace with these dynamics: The standardization is a very well-organized process, with two standardization meetings per year via the International Vision Standards Meeting (IVSM), with more than 100 participants, plus an international cooperation for very well-performing standards. With GenICam, we provide a software standard that is accepted by all interface standards and is pushed forward together, and a multitude of standards were developed in the past.

The G3 board is composed of the international industry associations: Automated Imaging Association (AIA), China Machine Vision Union (CMVU), European Machine Vision Association (EMVA), Japan Industrial Imaging Association (JIIA) and the German Verband Deutscher Maschinen- und Anlagenbau e.V. (VDMA) that supervises and regulates the standardization initiatives – if necessary – to avoid dual developments.

inspect: The number of participants in your meetings has risen significantly since 2009. What impact has the rapid technological development we have seen on the working methods and the working group's objectives?

Dr. Klaus-Henning Noffz: A faster market access is important. To achieve this, the standards must be made available faster. In this respect, the higher number of participants reflects the high importance of standards and their time-to-market. An important encounter within the IVSM is the G3 Future Standards Forum (FSF), at which the participants discuss upcoming requirements for new standards at an early stage, in order to quickly tackle new developments. After the decision to follow a standard has been made, new working groups are assembled to solve current problems. For example, there is a group named CLHS/CXP Roadmap Committee (CCRC) that reconsiders synergies and of a possible merge of the two standards CoaXPress and Camera Link HS at optical data transfer level.

inspect: In your opinion: which of the current standards will still play a role next year?

Dr. Klaus-Henning Noffz: All of them will. The lifetime of machine vision products and standards is very long. The best example is, as mentioned before, Camera Link, which is the oldest standard in our industry

that enabled the breakthrough of industrial digital cameras. Camera Link is being further enhanced; with version 2.1 it will be thoroughly modernized and extended with GenICam. In version 2.1, this extension is optionally supported, but in version 3.0 the support becomes mandatory.

GigE Vision is the most important interface standard in image processing. Its importance will increase further with the breakthrough addition of NBASE-T and 10GigE.

To be honest, I cannot detect any stagnation for any of the standards. This is proven by the number of planned IVSM meetings, with approximately 70 hours of active work on seven standards and additional eight hours of practical compatibility tests.

inspect: Can industrial companies even wait for the results from industrial standardizers in the current market context?

Dr. Klaus-Henning Noffz: The market pressure exists, but there is no alternative. Without standards, we will end in proprietary dead ends. There are two ways to reach a faster standardization speed: more participants, and the G3 Future Standards Forum.

A good example took place in 2015 when I took the chair of the Embedded Vision Study Group (EVSG). Created in spring 2015, the group's final report was made available at the end of 2015. Proposals for taking over new or further developing existing hardware and software standards of this group were: MIPI, OPC Vision and GenICam extension. By now, all proposals have been realized. The group´s biggest success is the OPC Vision subject: The working group is intending to present a release candidate during this year's Automatica fair in June.

Across Germany, OPC Vision is the precursor to the Industry 4.0 standardization for robotics and handling technique, on which we are very closely cooperating with the VDMA.

inspect: The longevity of a standard has always been very important for the industry, will this remain a fact?

Dr. Klaus-Henning Noffz: Certainly, and this is especially valid in our industry where we have a high number of relatively small companies. No player is big enough to impose a standard on the rest of the market. Therefore, we depend on cooperation – and we realize cooperations in an exemplary way.

> *"I cannot detect any stagnation for any of the standards. This is proven by the number of planned IVSM with approximately 70 hours of active work at seven standards and additional eight hours of practical compatibility tests."*

Within the VDMA, Machine Vision is one of the most innovative departments, blossoming with ideas regarding standardization with the adjacent associations, such as robotics.

OPC Vision is the best example for these initiatives, with the result that a myriad of other associations is engaging themselves with high priority. Today, we are working on standards for all industrial engineering markets, i.e. Industry 4.0, across the board. In doing so, we create enormous synergies across a whole industry sector. In my opinion, such a program has no alternative in the current times of worldwide networking.

inspect: To which extent do you see the consumer industry as a pacemaker for future developments?

Dr. Klaus-Henning Noffz: Many of the essential technologies stem from the consumer goods industry and are adopted by us. An advantage is above all the price. A good example is USB Vision, i.e. the adoption of an economic interface for industrial cameras.

A very current example is MIPI (Mobile Industry Processor Interface) from the telecommunications industry which many companies regarded as a very interesting candidate for embedded image processing systems.

inspect: What are the new potential standardization projects you will be discussing in the plenum this year?

Dr. Klaus-Henning Noffz: Our industry is trying to introduce an industrial MIPI, but I consider OPC Vision the most important one. This is a software communication standard for Industry 4.0, and it reaches far beyond our industry. OPC Vision is also built on the existing OPC UA standard and, in its context a general interface to an image processing system is defined. This is of enormous importance for all system integrators as it removes an immense constraint for image processing systems.

In my opinion, the component manufacturers have not yet completely understood the relevance and opportunities of OPC Vision. It is gaining importance for everyone who builds or wants to build embedded cameras. It is fascinating that at the IVSM standardization meeting in Frankfurt in May 2018, system integrators will intensively be comparing notes on OPC Vision with the view of component manufacturers for the first time. I am very curiously looking forward to this meeting.

inspect: Looking back at these potential projects you have been discussing since 2009, which will become important standards in the future?

Dr. Klaus-Henning Noffz: I have to say that the standardization proceedings are quite goal-oriented. The existing Camera Link and GigE Vision interfaces have been enhanced by CoaXPress, Camera Link HS, and USB Vision. What hasn't worked out so well though was to reach an agreement on a common successor to Camera Link, thus two standards evolved, namely CoaXPress and Camera Link HS.

inspect: What exactly is the "special group targeting embedded GenICam," to which extent is it a "special" group?

Dr. Klaus-Henning Noffz: The Embedded GenICam group deals with enhancements to GenICam that are needed for embedded cameras. It is important to understand that from the software side an embedded camera is a simple image processing system – but it has much higher integration requirements than a simple industry camera. In my opinion this working group is the key link that connects GenICam with OPC Vision. With the increasing success of embedded cameras this working group will play a very special role in the near future.

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Rising Demand for QA Equipment in Hard- and Software

Control Stuttgart, April 24 to 27: Trends in Quality Assurance

In our interview with Bettina Schall, Managing Director of the trade fair organizer Schall, she explains that despite inline processes there will always be room for classic metrology, why she sees quality assurance as the key for digital production, and which role science plays for Control.

inspect: This April, Control already takes place for the 32nd time – with more exhibition space and probably more exhibitors, too. Where do you see the reasons for the growing interest in quality assurance technologies? Does the additional exhibition space come along with new topics?

Bettina Schall: In contrast to former times, quality assurance today is no longer an expensive but necessary evil. Yet, it has become a cross-divisional function in companies that has an influence on the value chain. Lower quantities result from a rising number of product variants, and that, in turn, requires high production flexibility. In order to produce economically and competitively, every process has to have a certain quality, and expensive scrap production has to be avoided. This requires targeted investment in quality assurance, and, as it affects all manufacturers, the need for QA equipment in hard- and software is constantly rising. As a consequence, the offer is broadened. This can be traced back rather to the application variety of the existing technologies that need optimization than to real new topics.

inspect: In your opinion, what are the most important topics in optical (non-contact) metrology?

Bettina Schall: These are laser technology and above all camera and vision systems, last but not least also sensors. They all enable the possible applications of optical metrology, non-contact metrology respectively. Real innovations include for example 3D scanning and inspection systems which, to a large extent, are based on optical systems, too, and build the foundation of high-speed scanning of complex 3D workpieces such as turbine components.

inspect: Will classic metrology continue to be of importance or will everything operate inline soon?

Bettina Schall: Quality assurance, for example in mechanical manufacturing, is practiced both offline and inline. Measurement- and process-controlled precision machining are state-of-the-art, but they are nowhere near replacing the classic measurement of parts with the help of CNC coordinate systems in the measuring room, including constantly documented product quality. Complete networking and analyses as well as the fast and accurate interpretation of QA data from manufacturing are crucial. Expensive mistakes can only be prevented if corrective measures are taken promptly.

inspect: To which extent is digitalization reflected in the exhibition halls? What does this development mean for modern inspection technologies?

Bettina Schall: To be precise, quality assurance is the key to digital production towards Industry 4.0 as the inspection and measurement data of every process step influence, not to say control the further proceedings. This starts with incoming goods inspection and ends with function control/final check before dispatch. There is hardly any QA relevant product presented at Control that is not absolutely I4.0 capable and cannot be integrated into a superordinate QA system via defined interfaces.

inspect: The Fraunhofer Alliance Vision is taking digitalization with their focus topic Individualized quality assurance with image processing. How important are the interlocking of industry and science for Control?

Bettina Schall: We are pleased to be able to support knowledge transfer between research and industrial application with partners like the Fraunhofer Alliance Vision, Fraunhofer IPA, and others. It is one of the dedicated objectives of Control as a specialized trade show to promptly provide the broad expert audience with the latest insights, especially those from basic research. This type of transfer accompanies Control like a catalyst, and it supports the development of totally new market segments.

inspect: Is there a final tip from you for the visitors of Control?

Bettina Schall: Along with the extension of the show to a new hall and the construction and infrastructure measures recently completed by Messe Stuttgart goes a new hall layout with short distances. The revaluation if not equality of the West entrance in comparison to the East entrance enables time-saving access to all halls, i. e. focused, direct visits to the companies you are aiming at. Our new homepage and social media connects offer all necessary information to best plan and organize your show visit in the run-up. Moreover, a selected supporting programme enables visitors to overall inform themselves so they can obtain decision-making reliability for purchases or investments.

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CHII 2018

The Meeting Point of the International Hyperspectral Imaging Scene

The fascinating possibilities of the industrial use of hyperspectral imaging will be showcased at CHII (Conference on Hyperspectral Imaging in Industry) 2018 from 6 to 7 June 2018 in Graz, Austria.

For the third year, the hyperspectral imaging pioneer Perception Park invites experts and users from all over the world to the chii conference in Graz to discuss the latest technology developments and their use in industrial applications. The world's only conference with a clear industry focus on the ground-breaking possibilities of hyperspectral image processing unites all stakeholders for interdisciplinary exchange. Application engineers, hardware producers, research institutions, plant operators, international distributors as well as the main manufacturers of sensors, optics, lighting and software are represented along with service providers presenting consulting services, order developments and complete turnkey solutions.

Hyperspectral imaging can be used to record contaminants and foreign bodies in real time in sorting and manufacturing processes, in addition to capturing the concentration and distribution of chemical ingredients (for example in food or pharmaceutical products). This is the unique selling proposition of the technology – particularly in the food, packaging and pharmaceutical industries as well as in the wood and recycling sectors. CHII 2018 however, being a cross-sectoral conference, is not limited to these fields and will demonstrate solutions for the needs of a wealth of applications.

CHII 2018 is based on three pillars: during the morning session on both conference days, the Collaboration Forum will feature 10-minute presentations by industry representatives, providing a compact overview of the latest developments in hyperspectral imaging. Following this, during so-called CHII talks, conference participants can conduct meetings with other attendees which can be arranged online in advance at www.chii2018.com. Finally, during the afternoon training sessions will be held on both conference days to help participants learn more about the state-of-the-art handling of hyperspectral technology. The training sessions will be organised as workshops on dedicated topics. The workshop on day one will be delivered by EMVA (European Machine Vision Association) and will deal with the topic „Characterization and Evaluation of Multi- and Hyperspectral Imaging Systems". The second day's workshop will focus on the theme "Application of Multi- and Hyperspectral Imaging in Biology, Medicine and beyond".

Alongside the conference an exhibition will run in which experts in industrial hyperspectral imaging present their latest technologies and allow visitors to experience these first hand.

"The conference will give enormous impetus to the further development of this promising technology and its broad industrial application," according to Manfred Pail, organiser of CHII 2018. "With a tailor-made conference concept we ensure maximum networking, communication and exchange and thus lay the groundwork for a series of interdisciplinary cooperation projects across the entire value chain."

The conference participation fee is € 550. Early bird registrations receive a € 100 discount when registering before April 30, 2018. More information about the programme and registration is available at www.chii2018.com.

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Proud winners: Helge Vogt, Agnes Hübscher, Edmund Optics; Heinrich Brüderle, WenzelGroup; Marc Burzlaff, Peter Martienssen, Engrotec-Solutions.

And the Winners Are ...

Presentation of the inspect awards 2018 at SPS IPC Drives

Beginning 2017, the inspect editorial team had called the industry to participate in the inspect awards 2018 with their product highlights. In June 2017, the jury of experts selected 11 top vision, automation and control products from the multitude of entries for the inspect readership to vote. The preselection was presented in detail in inspect issue 3/2017. Afterwards, our readers voted for their favorites at inspect-online.com. Finally, in inspect issue 6/2017 we presented the winning products.

The official award ceremony took place at SPS IPC Drives show in Nuremberg in November 2017. At the end of the first show day, Joachim Hachmeister, Editor-in-Chief inspect B2B, and Oliver Scheel, Commercial Manager, handed over the popular trophies during a small celebration at Wiley-VCH's booth. The winner companies were:

1st place in the category Vision
Edmund Optics – Robust camera lens series Cr

1st place in the category Control
Wenzel Group – Compact-CT exaCT U

1st place in the category Automation
EngRoTec – AI Robot Guidance System

The winners were very pleased and thankful for the positive readership votes their product highlights had received.

Agnes Hübscher (Marketing Director Europe), Helge Vogt (Sales Manager Europe), Edmund Optics:
"Winning the first place in the category vision of the inspect award 2018 with EO's Techspec lens of the compact ruggedized (Cr) series with fixed focal length shows us that ruggedization currently is an important topic. Be it the use on robots or in the area of precisely calibrated 3D metrology in general – the requirements for the robustness of optics are very demanding with regard to vibration, shock, accelerations and temperature fluctuations. Edmund Optics would like to thank the inspect readership for every single vote! We consider the first prize a confirmation of the Cr lenses as a good response to current market and customer requirements."

Heinrich Brüderle, Sales Manager Europe and America, WenzelGroup:
"We are proud to have won the first prize in the category control of the inspect award 2018 with our universal computer tomograph exact U. The exact U sets new standards in industrial computer tomography, and we are especially pleased with the market recognition. This shows us that we are on the right track with our development."

Marc Burzlaff, Peter Martienssen, Managing Directors, Engrotec-Solutions:
"We are extremely pleased to win this prize. It shows us that we have been able to contribute to the simplification of the increasing complexity of automation tasks with our AI Robot Guidance System. We would like to thank our customers and all the readers who voted for our system in this strong competition. We would also like to thank our team for the excellent development work."

After the Award Is Before the Award

This year, the inspect award will be presented at Vision show in Stuttgart in November. Companies that would like to become one of the winners with their product highlight should enter the awards early. Entries for the inspect award 2019 can be made at the following websites:
www.inspect-award.com (English)
www.inspect-award.de (German).
Deadline is April 30, 2018.

Vision Stuttgart

Just eight months before this year's Vision opens its doors in Stuttgart from 6 to 8 November, the preparations for the leading world trade fair for machine vision are well under way. "The prospects are highly promising," said the organizers during the joint CEO Round Table of Messe Stuttgart and the VDMA Machine Vision Association at the Stuttgart television tower. "The industry is still on a growth path. In Germany alone, growth in the machine vision industry in 2017 provisionally amounted to 18%. Throughout Europe turnover in the machine vision industry rose by between 12% and 14% last year. All the forecasts point to another successful year in 2018," said Florian Niethammer, Team Director at Messe Stuttgart, with optimism. Over 450 exhibitors are again expected to take part in Vision 2018. More than 300 companies from all over the world have already registered for the trade fair. In addition to traditional industrial applications, non-industrial applications have also become much more important in the last few years. The exhibitors will therefore present, for example, applications for the areas of traffic, food and beverage technology, and medical technology. Machine vision is also gaining ground in the agricultural sector, for example in sorting tasks during or after harvesting, in so-called precision farming or through greater use of drones. "We have an exciting Vision year ahead of us, all the signs still point towards growth. The industry is also preoccupied with the megatrends of embedded vision and deep learning," emphasized Niethammer. With embedded vision, machine vision intelligence is migrating from external PCs into devices. The biggest drivers of embedded vision technology at present include autonomous driving, but also integrated face and object recognition in smart cameras or surveillance cameras.

www.messe-stuttgart.de

Sensor+Test 2018

Digital transformation demands rethinking of established products, services, and value-added chains. Linking sensor and measuring technology with cyber-physical systems in the Industrial Internet plays a crucial part in this transformation. The next Sensor+Test from 26 to 28 June will therefore deal extensively with this exciting topic – and its numerous effects on all suppliers and users of sensor, measuring, and testing systems – at special forums and community stands.

Special Topics will be "Sensor and Measuring Technology in the Industrial Internet", "Digital Transformation" and "Vision Sensors and Systems". The number of available stands of the various formats is limited however. An early booking is highly recommended. Further information can be found at the Sensor+Test website, www.sensor-test.de/direct/application.

www.sensor-test.com

The Vision Show Boston

Hosted by AIA, the world's largest trade association for advancing vision and imaging, The Vision Show educates current and potential vision users about the latest advancements in machine and embedded vision, while offering them real-world solutions to their manufacturing challenges. Taking place 10 to 12 April, at the Hynes Convention Center in Boston, attendees typically span a wide range of companies and job titles, which makes for a lively show with interesting discussions among people who might not otherwise have the chance to connect. This year, AIA expects those at the show to include users of vision and imaging technologies, system integrators, automation integrators, makers of collaborative robots, drones, augmented reality systems, and much, much more.

With six conference tracks and courses ranging from beginner to advanced, The Vision Show has something for everyone.

To support AIA's new embedded vision initiative, there will be a track on embedded vision and an embedded vision pavilion this year. As one of the most exciting technologies in today's vision industry, AIA has also developed an embedded vision website: https://www.visiononline.org/embedded-vision, a resource for everyone from the new user to the expert.

www.a3automate.org

VDMA: CEO Roundtable

For eight years, the European industry has seen record turnover and growth figures. Machine Vision meets current trends. The reason: Not only is this key technology increasingly applied in the global race for automation in classical industry sectors, it is also perpetually conquering new fields of application. Standards, connectivity and easy integration as well as digitalization remain growths drivers. Embedded Vision and Machine Learning are opening up completely new areas and will provide the sector with fresh growth impetus. Participants of the CEO Round Table in Stuttgart discussed the reasons for the steady growth.

"Already today, Machine Vision is an integral component in automation. With the shift towards a digital factory in mind, the demand for process and quality data will increase further. There is hardly any sensor technology capable of contributing to the extent which Machine Vision does," said Heiko Frohn, CTO at Vitronic GmbH.

Lou Hermans, Ph.D., Partner at Capital-E, described the reasons for the high interest in Machine Vision: "Investment opportunities in machine vision related topics today are mainly in the field of the 'consumer' industry such as automotive, drones, AR/VR, health and security. New developments are driven by performance, weight, size, and cost reduction. Because of data throughput local or so-called edge computing will become more important. This drives the development of dedicated and integrated low power processing, so that only relevant data are transmitted for further analysis."

Dr. Dietmar Ley, CEO of Basler AG, expects a consolidation in the machine vision industry: "The speed of consolidation – which has been low over decades – has significantly accelerated over the last 36 months. Further acceleration is probable due to three trends:
1. Computer Vision and Machine Vision are attracting increasing attention from strategic and financial investors. Vision technology will play a major role in the Internet of Things/Industry 4.0 realm, which are considered dynamic and sustainable future growth markets by strategic and financial investors.
2. The traditional machine vision market is quickly maturing.
3. More and more founders of classical machine vision companies are approaching retirement."
Detailed statements and figures are available at VDMA's website.

https://ibv.vdma.org/de

Index

Imprint

Published by
Wiley-VCH Verlag GmbH
& Co. KGaA
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Bank Account
J.P. Morgan AG Frankfurt
IBAN: DE55501108006161517443
BIC: CHAS DE FX

Advertising price list
from October 2017

Circulation
10,000 copies

Individual Copies
Single copy € 16.30 plus postage.

Pupils and students receive a discount of
50 % at sight of a valid certificate.

Subscription orders can be revoked within
1 week in writing. Dispatch complaints
are possible only within four weeks after
publishing date. Subscription cancellations
are accepted six weeks before end of year.

Print
Pva, Druck und Medien, Landau

Printed in Germany
ISSN 2567-7519

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