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Machine Vision and Optical Metrology

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SPECIAL TOPICS:

Vision 2018

Embedded Vision

Spectral Imaging

3D Measurement

Speed, Distance, Flexibility

Multi-camera Systems with 64Gbit/s Technology

3D Technology for Innovative Business Cases MARKETS

The Challenges and Importance of Plastics Recycling CASE STUDY

Edge or Cloud: It´s All Embedded INTERVIEW

Partner of
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TAMRON MP2030M-GS
CAMERA MODULE

with 1/1.8“Full HD Global Shutter CMOS (IMX265)

GLOBAL SHUTTER

To provide best possible picture quality, Tamron`s MP2030M-GS is utilizing SONY IMX265 CMOS sensor. With its latest, optimized pixel generation it is perfect for the high demands on image quality in most Machine Vision applications.

FULL HD

MP2030M-GS can output Full HD (1920 x 1080) video at 60 fps. Thanks to its high dynamic range, the video image brings out rich details of dark and bright image areas in the same scene.

30x ZOOM

Tamron’s “newest eye for industry” is the first camera module with a CMOS Global Shutter sensor and an incredible 30x optical zoom range.

GLOBAL SHUTTER

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industrial.tamron.eu

Plastics? No Thanks!

Do you use a cotton shopping bag? Refill your soap dispenser at home instead of throwing it away and buying a new one? Or bring a thermos cup for your favorite 'to-go' coffee shop experience instead of using a plastic-coated disposable cup? Great, then you are already contributing to replacing and re-using plastics!

Plastics are convenient, useful, they swim in the ocean and last for thousands of years. No other material embodies today's consumer society's blinkers as much as plastics. It's high time we reduced consumption. Or at least recycled and re-used plastics better. How hyperspectral imaging can contribute to the better sorting and recycling of plastics, for example by supporting the re-use as secondary fuels, is explained in two of the articles in this new edition of inspect international.

Many more articles on impressive 76 pages are leading the way up to this year's Vision show in Stuttgart from November 6 to 8. They comprise topics in the field of embedded vision, spectral imaging and 3D measurement, including deep learning, one of the focal points of Vision. Check out our show preview and the interview with Messe Stuttgart for more details about what to expect at the show this year.

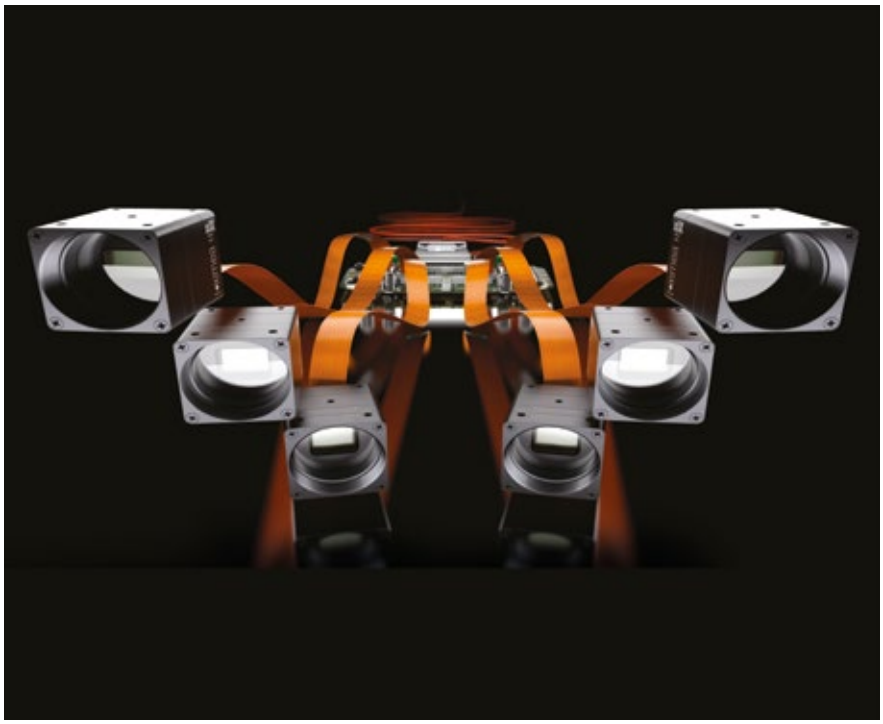
Our cover story deals with multi-camera systems and how a platform based on the PCIe interface can boost their performance in various areas by overcoming limitations. It is exciting to see how digital cameras have evolved since the days of classic movies.

Last but not least it's time for the renowned inspect award again. 10 companies are competing with their latest innovations in the categories 'Vision' and 'Automation + Control'. You can support your favorite with your vote at www.inspect-award.com and automatically enter the prize draw for a high-quality reflex camera until October 15, 2018.

But now, first of all, enjoy our magazine – and remember to keep an eye on your dealing with plastics.

Yours sincerely,

Sonja Schleif



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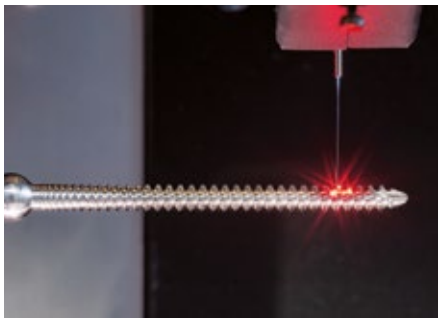

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Events

Divisional VP Project and Product Management

Ametek Surface Vision has enhanced its senior management team with the appointment of Jason Zyglis to the newly created role of Divisional Vice President of Project and Product Management. A graduate of the State University of New York College of Environmental Science & Forestry at Syracuse University with a degree in Paper Science (Chemical Engineering), Zyglis transitions from Ametek Surface Vision's Director of Sales - Americas to Divisional Vice President of Project and Product Management to now lead the business unit's product management process and project engineering team. Rising from within the organisation, he brings two decades of experience focused on strategic product marketing, sales and business development.

"I am driven to solve challenges that end users encounter at critical stages in the industrial processing environment with innovative visual technology. I am delighted to lead the project and product management for the largest and most-respected surface inspection and monitoring company in the industry," comments Zyglis.

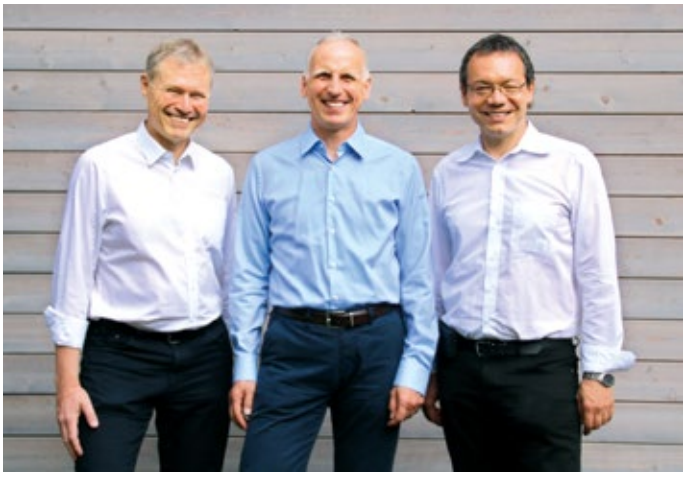
www.ametek.com

New Climate Chambers

Responding to the growing demand for CT metrology applications, Yxlon has invested in four additional climate chambers in Hamburg, Germany. Two chambers are dedicated to R&D for new and ongoing technology development; the other two are part of production, where the FF20/35 CT metrology systems are fine-tuned for accuracy.

Computed tomography is a technology capable of properly measuring and analyzing even internal structures of parts. Hundreds of high-resolution X-ray images taken from all angles are used to reconstruct a three-dimensional CT volume, which can then be visualized and edited with suitable software. Modern X-ray technology and sophisticated detectors can scan down to micro- and even nanometer scales. This makes them well-suited for the requirements of electronics manufacturing and new production technologies such as 3D printing. With their granite base, quality manipulation unit, temperature-controlled cabinet, and the stable focal spot of their micro- and nanofocus tubes, Yxlon CT metrology systems are perfectly equipped for these tasks.

www.yxlon.com



From left to right: Klaus-Henning Noffz and Ralf Lay, both Silicon Software, and Dietmar Ley, Basler

Basler Acquires Silicon Software

With the acquisition of Silicon Software, Basler complements its product portfolio towards the performance segment of the Computer Vision Market. Basler takes over 100% of the shares of Silicon Software with immediate effect. The two managing directors Klaus-Henning Noffz and Ralf Lay will be working for Silicon Software and Basler in the future.

Basler continues to expand its product portfolio for Computer Vision applications with this transaction. Camera customers will benefit from comprehensive and easy-to-integrate solutions for capturing and processing images in the future. With a view to next-generation image sensors and their associated higher data rates; easy-to-use high-performance image acquisition cards are becoming increasingly important. By combining Basler's cameras with intelligent image acquisition cards from Silicon Software, customers will receive solutions from a single source in the future, which already allow pre-processing and analysis of image data "on board" and open up cost-cutting potential. The graphical programming of the vision processors via Silicon Software's VisualApplets software leads to shorter development times and faster time-to-market cycles for customers.

www.baslerweb.com

Martin Buchwitz Joins inspect Team

The editorial team of inspect, the specialist magazine for applied machine vision and optical metrology, has been reinforced: Martin Buchwitz, Deputy Editor-in-Chief, will bring in his many years of automation expertise.

Buchwitz worked for Jetter for almost 20 years, mainly in the area of marketing communication with a focus on press and public relations. He then supported SPS-Magazin as editor-in-chief, before devoting himself exclusively to his hitherto voluntary work in the ecclesiastical field. Now he is drawn back to automation technology in order to accompany the exciting and highly innovative industry of industrial vision journalistically with the magazine inspect.

www.wiley.com

Basler: Joint Venture with Beijing Sanbao Xingye

Industrial camera manufacturer Basler is strengthening its position in the Chinese market by joining forces with Beijing Sanbao Xingye (MVLZ) Image Tech., a Chinese distributor of image processing components. Basler signs a joint venture agreement with its distributor, Beijing Sanbao Xingye (MVLZ) Image Tech.

Beijing Sanbao Xingye (MVLZ) Image Tech. has been Basler's distribution partner in China for close to twenty years. The company distributes image processing components and consults its customers in machine vision and scientific imaging. Both companies agree to transfer the Machine Vision division to the newly established Beijing-based Basler China with branch offices in Shenzhen and Shanghai. The management is staffed by employees of both companies.

Asia, and especially China is a strategic growth region for Basler, where the company takes another step towards building its business. The joint venture agreement with Beijing Sanbao Xingye (MVLZ) extends Basler's direct presence in the Chinese market.

www.baslerweb.com

From left to right: Dietmar Ley, CEO of Basler, and Guan Qunli, Chairman of Sanbao Xingye (MVLZ)

Simone Cronjäger, Founder and Managing Director of Guardus, and Dr. Jochen Peter, Member of the Executive Board of the Zeiss Group and President & CEO of Carl Zeiss Industrielle Messtechnik, announcing the acquisition

Zeiss Acquires Guardus

Zeiss and Guardus have announced that the software solutions supplier for computer-supported quality assurance and production management systems based in the German city of Ulm has become a wholly owned subsidiary of the Zeiss Group.
For Zeiss, the integration of Guardus into its Industrial Metrology (IMT) business group will further strengthen its own position as a partner for increasing productivity in digital manufacturing. The Computer Aided Quality (CAQ) applications and Manufacturing Execution Systems (MES) from Guardus provide customers with a fully integrated analysis and steering function for production.

Initially, the joint customer focus will be on the automotive and engineering industries as well as medical technology. Guardus' existing sites in Ulm and Timisoara, Romania will be retained. For the approximately 60 employees, business operations will be transferred as per German legal provisions.

www.zeiss.com

New Office in Silicon Valley

Allied Vision has opened a new Sales and Support office in Cupertino, California. Located in the heart of Silicon Valley, this site will allow the company to provide better service to the growing customer base in the high-tech industries. "Our business has experienced strong growth in Silicon Valley over the past the few years", explains Michael Troiano, Sr. Director, Worldwide Sales at Allied Vision. "It is a global hub for technological innovation which extends into developing new imaging applications. We feel that a local office gives us a unique time to market perspective and will help us prepare for closer collaboration with emerging applications and companies." Allied Vision currently serves the North American market out of its Sales Office in Exton, Pennsylvania. Having a local office will help increase customer intimacy on the west coast with no distance and time zone differences. www.alliedvisiontec.com

Launch of Halcon 18.11

MVTec Software announces the new version 18.11 of its standard software Halcon for November 2018. Halcon 18.11 will officially be introduced at Vision 2018 and, amongst other things, will include new AI technologies, specifically from the fields of deep learning and convolutional neural networks (CNNs). Moreover, the latest release offers new and expanded options for embedded vision as well as updated USB3 Vision interfaces. In addition, core technologies will be further improved. For developers, the new version provides helpful innovations and valuable new features in Halcon's integrated development environment HDevelop.

The new Halcon 18.11 release comes in two editions: Steady and Progress. While the latter is available as a subscription with a six-month release cycle, the Steady edition – as successor of Halcon 13 – is offered for regular purchase. This includes regular maintenance updates (until the subsequent Steady edition is released), as well as MVTec's proven long-term support for customers. The Halcon Steady edition has a two-year release cycle.

www.mvtec.com

Speed, Distance, Flexibility

Multi-camera Systems with 64Gbit/s Technology

High speed PCIe interface streamlines multi-camera systems in various areas and enables peak performance.

Since the days of film that are quickly passing by, digital cameras have come a long way. The growth of both technology and capability in this sector has led to an explosion of applications using multiple cameras (and also the data of other sensors) as input. From simple stereo systems and medical imaging to virtual reality (VR) and cinematography, the number of applications that use multiple cameras to collect data is growing quickly. Additional application areas include motion tracking, mapping, cinematography, machine vision, 3D scanning, and orientation.

In a nutshell, a multi-camera system (MCS) is simply an assembly of multiple cameras collecting data for a joint or mixed (eventual) output. Multi-camera configurations face a lot of challenges which will be explored hereinafter along with the particular constraints the methods can place on applications. Ximea has developed a particularly suitable camera platform based on the PCI Express interface that helps to overcome many of the limitations imposed by other design paradigms.

Technical Challenges

Multi-camera systems present a number of challenges to the designers who have to implement them in their applications. While many solutions abound, they all have their challenges, and it is tough to find a camera design paradigm that addresses them all.

Data Throughput

Simply moving all this data from multiple (usually high-speed or resolution) cameras is a challenge by itself. Data rates can quickly exceed the limits of many of the interfaces used by most camera manufacturers. One camera may work well on a USB3 interface, but if multiple cameras are sharing the same controller, they must share bandwidth, which could result in limitations of the resolution, of the frame rate, or both. Processing or storage limits also restrict the performance of MCS and must be taken into account. Modern solid-state hard drives in high speed RAID configurations are

> *"Virtually unknown as a camera interface, PCIe has the capability to revolutionize the use of multi-camera systems."*

typically the best way to handle the high bandwidth of MCS. GPUs are often used to handle this data flood when processing is needed. Even basic color processing can be laborious if simultaneous streams from multiple cameras are input to the CPU/GPU. FPGAs can also be used for similar results, but they may not be as easily available or programmable as the ubiquitous GPUs on modern video cards.

Size

Smaller is always better – ask any of the MCS integrators. Even an outside-in orientation could benefit from the small size of the camera and infrastructure to help stay out of the way of other components (lighting, sound, scaffolding, data and power interconnections, etc.). One often overlooked contribution to the overall size of the system is size of the connectors. Even small cameras can be doubled in length when including the size of the attached connector. USB cables are inherently large at the business end, and even the smallest camera can be made too large for a given application simply because of the cable.

Meta Data

Nearly every application needs some extra information to be stored with the image data (GPS coordinates, time, instrument parameters, etc.). This information is recorded synchronously or asynchronously by various sensors and must be transmitted to the processing computer in parallel to the image data from the cameras. In addition to the fast camera interfaces, further data interfaces must be supported if required.

Optics

A persistent challenge for imaging applications is the optics. Area sensors need a high-quality lens to form an image. Imaging quality comes at a price in the optics borne out in the size, complexity and cost of the lenses mounted to the camera. Too often, MCS are limited by the physics of glass and light, not the digital technology to move large volumes of bits from one place to another.

Synchronization

Undoubtedly, MCS must have some sort of synchronization, either with external components, from camera to camera, or usually both. Again, another cable must be run to each involved component in the system to accomplish this critical feat. Often, synchronized, dynamic multi-camera systems benefit from the use of global shutter sensors.

Current Platforms

The camera industry has been flooded with consumer-based products for ever decreasing prices. But, as anyone who has tried to create an MCS can attest, they are not the cure for all imaging problems. The computer interface for moving data around is critical to the success of an MCS, but the pros and cons will dictate the most suitable solution for any given application. Some of these have been discussed previously but will be touched on as the various platforms available today for MCS are discussed:

- bandwidth,
- price,
- complexity,
- cable connectors,
- cable length,
- power consumption,
- latency,
- aggregation.

USB/GigE

Likely the cheapest and most common interfaces are GigE and USB. These are ubiquitous on modern computing platforms, and while quite different at the base level in terms of data transfer they have similar pros and cons and are lumped together in this discussion.

These interfaces are simplest to implement. There are many stand-alone software packages supporting cameras with these interfaces. Off-the-shelf hardware is readily available to help aggregate these cameras into an MCS. Power distribution is simplified as the USB protocol allows for some power to be transmitted alongside the data signal, as well power over ethernet is possible in some GigE implementations. The complexity of aggregation for these cameras is low, but any group of these cameras put into the same MCS will usually be sharing the total bandwidth available. Generally, these interfaces do not have high power consumption. But this is more of a side effect of low bandwidth rather than a design feature. There is processing which must be done on one end of the transmission or both which attributes to extra latency with these interfaces. This processing comes at a cost for power consumption as bandwidth rises (as with 10 GigE).

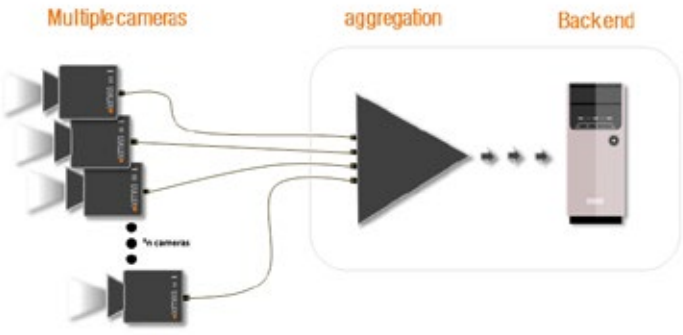
Interfaces such as 10 GigE or even 100 GigE are just coming on-line in the market and will not be discussed until later.

Camera Link/CoaXpress

A very popular interface for high-speed cameras are Camera Link and CoaXpress. While high speed, and capable of interfacing via multiple cables, they are some of the more expensive interfaces since frame grabber boards (and sometimes custom cables) are necessary. The high speed comes with high power consumption. The high frame rates don't necessarily lead to low latency as processing from the CPU is still needed to have the data ready in RAM for further processing. Aggregation of data in this case is non-trivial as each camera needs its own frame grabber in the host PC for saving or further processing.

PCI Express

One of most common interfaces, but virtually unknown as a camera interface, PCIe has



A typical MCS configuration

The Ximea xSwitch offers up to 24 PCIe camera ports, up to 8 USB3 connectors, synchronization, and a bandwidth up to 64 Gbit/s.

the capability to revolutionize the use of MCS. Most computing platforms have a PCIe backbone ready in the system, and a PCIe camera simply becomes another device on the bus with direct access to RAM (and thus the CPU/GPU). Bandwidth for this interface is very high and starts at 5 Gbit/s for the older generation (Gen 2) protocol at single lane speeds. The current protocol most often found in modern PCs is generation 3 with 8 Gbit/s data rates per lane, and Gen4 with 16 Gbit/s per lane will be coming soon. Multiple lanes are often used to accumulate bandwidth. For example, a Generation 3, 8 lane system offers 64 Gbit/s, about 13 times that of a USB3. Latency is inherently low as the CPU can nearly ignore the entire process of data transport and is free for other tasks (such as processing the data arriving in RAM). This interface is intermediate in complexity for aggregation as many cameras can be multiplexed when using a properly designed switch to input the data from multiple devices. Power consumption can get high for these cameras since bandwidth is high, but otherwise is kept to a minimum because there is little to no overhead in the transportation process. Multiple cabling systems for PCIe are available, but they are not widely known. Server farms which must move large volumes of data between one server to another frequently use direct PCIe connections through iPass cables. The iPass cable has been a standard for some time and is available in lengths of hundreds of meters for fiber optic versions. Ruggedized cable options are also available. The pricing of the cables may limit the decision to use this interface in some MCS implementations since these are not common standards to this point in time. A newer system is the FireFly system that promises compact size, reasonable cable lengths via copper connections, and longer distances over optical connections.

xPlatform

Ximea has capitalized on PCI Express in recent years and has developed a camera communication platform based on this. Many sensors are able to utilize the increased bandwidth available from this interface (currently up to 64 Gbit/s) as well MCS can realize the full input from many cameras running at video frame rates (and higher) fully synchronized directly into a single computer with one data cable input to the PC.

The cameras used in an MCS can be multiplexed with a device called a "PCIe packet switch". These allow the input of multiple PCIe data streams (including USB) into a single high-speed data interface. The current implementation of the technology available from Ximea allows for 64 Gbit/s speeds over iPass and ribbon cables. Future developments include innovations such as increased bandwidth (16 lanes and Gen 4) and even smaller connectors.

The configuration of a switch (Ximea branded products are called xSwitch) is often a custom exercise developed for specific customers and/or applications. The number of cameras which can be input into a switch is dependent on a number of variables, but the switch extends all the benefits of a PCIe camera into an MCS.

- Output bandwidth must be sufficient for framerate needed from each camera in the chain.
  - If total bandwidth summed from each camera exceeds output maximum, each camera's bandwidth budget is reduced by a concomitant amount.
- Common output from xSwitches uses Gen3 8 lane PCIe for 64 Gbit/s:
  - can handle at least 6 X2G2 Ximea cameras at full framerate (i.e. 9 4k cameras at 60 fps),
  - can handle at least 3 X4G2 Ximea cameras at full framerate (i.e. 6 8k cameras at 30 fps),
  - can handle at least 4 USB3 cameras and 2 X4G2 cameras.
- xSwitches have the capability to distribute trigger signals to each camera in the chain or for full synchronous function.
- Cameras in a switch system all have low latency.
- Cabling – many options available:
  - iPass: 7 m copper cables, over 100 m for optical,
  - Firefly: A new standard whose max bandwidth and length are still being determined,
  - Ribbon cable: a short-distance interface, but ideal for tightly packed camera configurations.

The xPlatform includes adapter boards that change between different cabling technologies. For instance, multiple xiB cameras with native iPass interfaces can run many meters (with fiber cabling) to a receiving switch using boards to adapt the large iPass connector into a high speed fiber optics cable at the switch, which can then interface to the controlling PC via a single high-speed PCIe connection. For instance, one customer implementation had an 'outside-in' camera configuration where each camera is looking inside of an enclosed space (3D VR imaging). Each PCIe camera runs a fair distance to its particular switch requiring an adapter from the cameras native iPass (running some 5 m to the ribbon cable which interfaces direct to the switch, which then runs fiber optic iPass (high speed X8G3 interface) to the controlling PC.

MCS with PCIe

Multi-camera systems will benefit from a number of the advantages of PCIe cameras. Increased bandwidth, low latency, distributed synchronization and multiplexing allow for the creation of a flexible, high performance interface capable of being adapted to many situations and applications. PCIe benefits from being a very established industry standard. The technology is supported by several manufacturers of high-speed adapter cards and cable manufacturers and is now also available in small embedded computers. Especially these environments benefit from PCIe as camera interface because the CPU is hardly loaded with the data transfer of the camera images.

PCIe is particularly suitable as an interface for small and high-performance MCS.

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Vision 2018 Hall 1, Booth 1C51

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Inspiring Business Models

How 3D Technology While Disrupting Industries, Helps to Create Innovative Business Cases

In the course of technology progress classical business models sooner or later become obsolete. What can be done about this? With the aid of 3D vision virtually any industry can create new business models.

Typically, traditional business models evolve from the current state of technology; these business models manifest themselves and pay the rent of the enterprising entrepreneur. When a technological disruption occurs, the process starts over again. In the current age of data, these disruptions happen continuously. Just think about Blockbuster and Netflix, Spotify and BMI, or LinkedIn versus other well-established personal services providers. These disruptions are perfect environments in which to learn and transform the knowledge that currently exists in the 3D imaging industry.

Tradition Versus the World of Data

Essentially, a business model dictates how an organization creates value and delivers this value to its clients. The competitive edge for industrial goods or raw materials is based on a specific technology, or production process. Customers pay for a certain technology or goods; new entrants into the market encounter hurdles in copying or improving upon the specific technology or product. The world of data is different. Technology opens opportunities, but soon commoditizes itself; therefore, its ability to provide a competitive edge is limited. Great databases are created while applying new technologies to the world of data. Then, data can be the basis for building enhanced user experiences. The data can create new business models with many advantages for companies over many decades. Competitive advantages based on data will be much more sustainable than the competitive advantages that are based on technology or production processes. Currently, corporate winners like Netflix, Spotify or LinkedIn, achieve and maintain their edge based on user data.

How 3D Technology Can Change Business

Depth information in the world of vision and 3D technologies is created by different technologies including Laser, Stereo-Vision, Multi-View, or Time-of-Flight. The current disruption is not the technology itself, but rather the economics of the technology. Raw 3D data in the form of depth maps, point clouds, and voxels can be employed in methods needed for upcoming applications. The example applications are object recognition for any security and surveillance application as well as situational awareness for autonomous vehicles. Here, an algorithm detects which objects are in the field of view and makes a decision based on the received image information. Obstacle recognition enables robots to collaborate in factories and helps drones to avoid crashes in challenging environments like forests. Simultaneous Localization and Mapping (SLAM) is a methodology by which 3D maps enable any kind of autonomous vehicle to navigate within its environment. Pose estimation is especially important for VR/AR applications to take the right perspective in their respective surroundings. In addition, it is of fundamental importance for gesture control. Dimensioning algorithms are especially important in logistics, where freight charges are partially based on the volume of an item. Addition-

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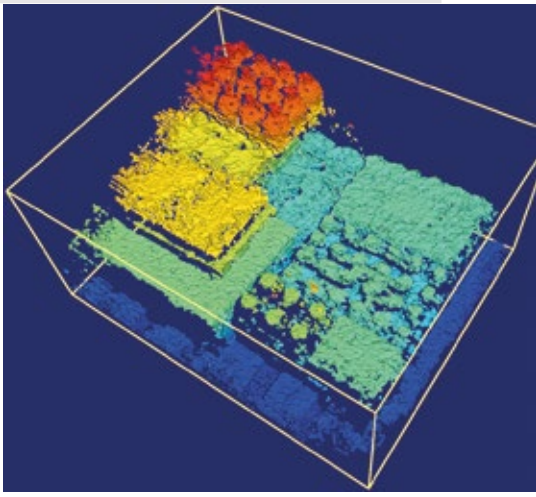

3D depth information of a pallet

> *"The current disruptions triggered by 3D vision are not induced by the technology itself, yet by the economy behind the technology. Many innovations will only become possible or enhanced by 3D technology."*

ally, dimensioning can determine the load optimization of both trucks and containers. Consequently, many applications are fundamentally enabled, or can be partly enhanced by 3D technologies. The question is; where are the market trends going? Yole Développement, a market research and strategic consulting company, forecasts a compound annual growth rate (CAGR) of almost 40 % in the 3D vision market. This forecast indicates a huge technological opportunity, and 3D offers the potential to enhance all industries. Most of the absolute growth comes from the consumer sector like automotive, white goods, cell phones, and home devices. Vacuum cleaners use 3D for navigating in home environments; accurate depth information at very low prices enables this 3D technology for consumer devices. In addition, a large portion of this growth is predicted for the industrial and commercial field, where 3D is implemented for process surveillance or robot guidance; people counting applications for stores; public buildings; and, public transport. 3D applications in industry supervise production processes, and control posture and gesture recognition applications in sports and entertainment. There is a huge potential for creating new business opportunities with 3D data and data-driven business models that are likely be established in the near future.

How to Create a Database for a Competitive Edge

Data is a valuable commodity but, how can its potential be realized? For a logistics project Framos manages to automatically unload sea freight containers with the aid of robots. The robots use both 2D and 3D vision to handle items in a container. In addition, semantic segmentation determines the edges between the boxes. A 3D camera determines how the robot shall approach and manipulate the item in the container, thereby creating a database about both the container and its contents. System performance based on this database increases tremendously, and virtually any item can be unloaded without error. In addition, reinforced learning is possible, as there is feedback about whether the unloading process worked adequately or if there were issues. Thinking outside of the box this data could propose different business models that could charge the carrier for the way the container is packed or the degree of automation that could be applied to the unloading process. If there is enough perspective on containers, even a business model based on the amount and types of goods that flow through unloading facilities appears to be realistic. Therefore, information about which and where goods are shipped can be applied to market-based pricing.

Autonomous Devices

Essentially, 3D technology is the fundamental basis by which to enable applications for autonomous cars, drones, and other types of robots that navigate autonomously. In addition, 3D mapping with SLAM provides completely new business opportunities. A complete 3D map can be created for a variety of current, fast growing applications. The accumulated data not only increases the robustness of the SLAM and the accuracy of the system, it is also a valuable resource with which to create a competitive edge. 3D maps of the world – inside buildings and out – can be created instantly; they provide innovative approaches to existing businesses. For example, some consumers still spend large sums of money on a vacuum cleaner robot. In the future, they could save a lot of money with leasing models that included advertisement. The intelligent and IoT-networked vacuum cleaner would be able to identify the exact size of the apartment, the floor plan, the brands and condition of the furniture and the individual furnishing styles. This data would allow conclusions about the level of the owner's income, and, with the appropriate consent, individualized advertising. This way, a furniture store could propose a couch to potential customers that matches the desired dimensions, style, and price based on their lifestyle. As a consequence, these data-based models would lower the purchase price of the intelligent vacuum cleaner as the manufacturer would draw his profit from selling user data. In addition, it is conceivable that customers could lease these vacuums on a per-use basis and receive advertising accordingly. It is important to remember one hypothesis from last year's embedded vision summit: In the future, 3D maps of the world will be much more valuable than Google Maps is today.

How to Start

Companies that want to benefit from 3D vision and brainstorm ideas for future business opportunities in disrupting markets have to consider their processes and applications thoroughly. Is there a way to enhance or enable the existing applications using 3D technology with corresponding methods like SLAM or object recognition? This premise allows the creation of a powerful database with which competitive edge can be established. Likely, it will be the basis for AI which uses large databases for its performance. Now, managers can brainstorm and think outside the box to determine the kind of data that can be collected and how it can be used. These steps are the basis for the development of promising business models based on 3D data in order to maintain the competitive edge while creating even more useful data.

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Vision 2018 Hall 1, Booth 1C42

inspect award 2019: The Nominees Are…

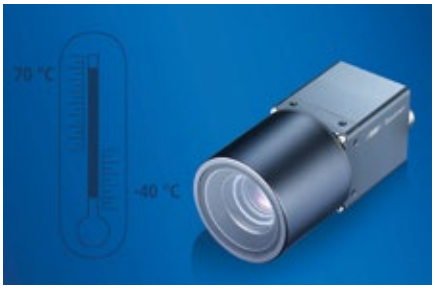
inspect award 2019

It's that time again – the inspect award is entering its decisive phase: the jury has nominated 10 products in each of the categories "Vision" and "Automation + Control" that we would like to present to you on the following pages. But which of these new developments actually offers the most innovation, the best value, the maybe decisive unique feature? With your vote, dear readers, you decide who shall be the winner. The three candidates in each category with the most votes will be honored with the inspect award at the Vision trade show in Stuttgart this November.

Vote now and win a camera!

At www.inspect-award.com you can vote online until October 15, 2018. All voters will automatically be entered in the prize draw for a high-quality reflex camera. Recourse to the courts is excluded.

Category Vision



Robust IP 65/67 Cameras From -40°C to 70°C

The cameras of the CX series with IP 65/67 protection provide an extended temperature range from 70°C to -40°C without the need for an extra protective enclosure. This eliminates the need for additional heating or cooling in quick and cost-efficient system implementation. Thanks to the hard-anodized housing, vibration and shock resistance up to 10 g/100 g, four outputs with up to 120 W (maximum 48 V/2.5 A) output power, exposure times starting with 1 µs, and frame rates up to 1000 fps the cameras provide maximum solution flexibility for demanding applications across all industries.

➔ **Baumer Group – www.baumer.com**

Quickly Focussed: Liquid Lens M12 Imaging Lenses

EO´s liquid lens M12 lens series utilizes the Varioptic liquid lens to enable the user to quickly focus anywhere between the minimum working distance and infinity. With the optical design being optimized to account for the liquid lens, this lens series offers high image quality on large sensor formats of 1/2" or even 1/1.8", depending on focal length. With the liquid lens being positioned at the aperture stop, all lenses operate at a very fast F/2.4. The intelligent opto-mechanical design supports the ease of use: Simply fully thread in the lens to the camera and use the liquid lens to focus from there.

➔ **Edmund Optics – www.edmundoptics.de**

High-speed Processing of Real-time Images

Based on Hikvision´s extensive background and technology advantage in audio and video, imaging acquisition, core algorithms and other areas, Hikvision has researched and developed the VPU Platform Smart Camera. The camera is embedded with the Intel-based artificial intelligence platform-Movidius VPU chip that can be widely applied in 3C manufacturing, auto parts and electronic semiconductors. The chip is equipped with a 12-core processor and two 32-bit RISC, providing superior algorithm performance and flexibility. In addition, the acceleration of the hardware system is optimized for visual processing.

➔ **Hikvision – www.hikvision.com**

Highly Flexible Image Processing Thanks to App-based Approach

Robust, compact, lightweight: IDS NXT vegas marks the kick-off of the new camera family of versatile, autonomously operating industrial cameras from IDS. The devices can handle image processing tasks independently or support PC applications with pre-processed data. Users determine individually which image processing task is to be performed by uploading and selecting vision apps. The camera (protection class IP65) includes an integrated 1.3 MP CMOS sensor, an integrated liquid lens, LED illumination, a ToF (time-of-flight) sensor for distance measurement, and an RS-232 interface.

➔ **IDS – www.ids-imaging.de**

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How Compact Can a GigE Vision Camera Be?

According to Lucid, with 24 x 24 mm width and height their Phoenix is currently the smallest GigE PoE camera in the machine vision industry. The camera uses a unique, compact design that can be transformed into different configurations for various OEM applications. It provides a Gigabit Ethernet connection that is widely compatible and easy to integrate for device control and communication. The camera is paired with an NF-mount lens that provides 40% space saving while maintaining the same imaging performance compared to similar C-mount lenses.

➔ **Lucid Vision Labs – www.thinklucid.com**

Creating Inspections without Knowledge of Image Processing

With mvImpact Configuration Studio it is possible for anyone to easily carry out inspections themselves - without any expert knowledge – and therefore enter the field of industrial image processing without any obstacles. The actual scene captured by the smart camera is automatically analysed, then suitable algorithms and filters are selected and the right parameters are set automatically. The user can choose from a manageable number of tools, whose names – such as "Set up camera", "Acquire image", "Find object", "Read code", etc. tell the user what they actually do.

➔ **Matrix Vision – www.matrix-vision.de**

Industrialized Embedded Imaging Module

Opto´s imaging module compact Eco USB is part of a new family of industrialized embedded imaging modules for system integrators and machine builders with which Opto delivers a new level of onboard machine vision devices. The module was particularly designed for the survey of production processes in factory automation, to detect micro-defects on metal parts, and for electronic components. The smart combination of onboard camera, optic, illumination, and electronic control interface delivers perfect and consistently reliable images.

➔ **Opto – www.opto.de**

Telecentric Lenses with Coaxial Illumination

The integration of a collimated bright field illumination inside a telecentric lens has already been a common principle for years. Due to large angles of incidence at the beam splitting surface, intensity varies considerably - especially for large field of view. The modular setup of Sill´s Correctal TA lenses offers the possibilities of an exchange of a polarized beam splitter to a non-polarized one and an add-on retardation plate to improve the polarized beam path. Therefore, an improved homogeneity and brightness of the illumination as well as a higher measurement precision can be achieved.

➔ **Sill Optics – www.silloptics.de**

Machine Vision Camera and Timing Master

By using the precision timing protocol IEEE1588 it is possible to increase precision to microsecond accuracy. In 2016, Sony launched the first machine vision camera capable of being an IEEE1588 master. XCG-CG510 and XCG-CG240 take this concept further to combine an acquisition scheduler as well as software-trigger, GPO-control and user set load action command types. This enables Sony's GSCMOS machine vision cameras to realise the industry's most precise pre-scheduled image acquisition synchronisation in real-world environments.

➔ **Sony Europe – www.image-sensing-solutions.eu**

Extremely Miniaturized 18 Mpix USB3 Camera

Ximea presents an update of their miniature 5 Mpix industrial camera to a higher-resolution and faster-speed model while keeping the extreme small-size benefits. With newly available, state of the art FPGA, micro connectors and other components it became possible to achieve enhanced resolution and speed at low enough heat dissipation. The 5K CMOS sensor with 18 Mpix (4,912 x 3,684) truly offers high resolution for most applications. A useful feature is the triggering and synchronization of multiple cameras through GPIO without the need for expensive frame grabbers or special software.

➔ **Ximea – www.ximea.com**

Category Automation + Control

3D Scanning CMM

Cube-R is a fast, reliable, and efficient complete turnkey solution for automated quality control applications. It is the perfect alternative to solve any productivity issues caused by bottlenecks at the traditional CMM. Unlike existing solutions, this scanning machine enables manufacturing companies to harness the power of optical 3D measurement and industrial automation. It maximizes the production cycle and throughput resulting in better product quality. It is ideal for the dimensional measurement of parts ranging from 1 to 3 m with a volumetric accuracy of up to 78 microns.

➔ **Ametek, Division Creaform – www.creaform3d.com**

3D Laser Sensors with 200 kHz Scanning Frequency

Based on the 3D sensor C5-1280-GigE, AT expands its series of 3D laser sensors with 4 new models. The new members of the C5-CS series impress with a compact design that allows high-speed 3D sensors to leverage their unique capabilities. The latest models all support an output of up to 1,280 points/profile and achieve a unique scanning frequency of up to 200 kHz. The entire design concept is tailored to the outstanding features of the high-speed 3D sensors and combines high-end 3D technology with the latest laser electronics in a compact housing.

➔ **AT - Automation Technology – www.automationtechnology.de**

Higher Frame Rates and Higher Resolution

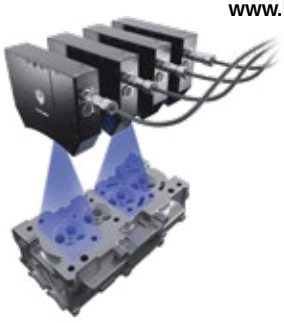
High resolution or high frame rate? The readout speed of the cameras limits their frame rate for a given number of pixels. InfraTec has now resolved this balancing act and offers an entirely new level of flexibility for its high-end camera series Image IR. Users can choose between two speed modes for the same camera. In standard mode, the familiar frame rates for full frame, half frame and sub-frame are available with full spatial resolution. In high-speed mode, images can be taken with the identical FOV – while the frame rates increase to more than three times the previous value.

➔ **Infratec – www.infratec.de**

Fast and Precise: Non-contact Volume Inspection

Tactile CMMs can accomplish volume gauging with a high degree of accuracy. However, this method can take more than two minutes per chamber, and all chambers need to be measured. For automotive component suppliers who need to verify high tolerances on medium-sized internal combustion engines, LMI has designed a 3D non-contact inspection method: The Gocator Volume Checker leverages several technologies (Gocator 3210 3D smart snapshot sensor, Gocator Development Kit and Accelerator, and a Master networking hub) to achieve high-speed, accurate volume measurement of cylinder heads and piston bowls.

➔ **LMI Technologies – www.lmi3D.com**



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Get Reliable 3D Microscope Data Quickly

The Lext OLS5000 combines 4K scanning and a large working distance with intuitive software to capture the shape of any sample under any angle. With dedicated objectives, an improved scanning algorithm and a 210 mm extension frame, the new 3D laser-scanning microscope can accommodate and measure a larger range of samples – as well as save time and improve productivity. Acquiring highly accurate data in less time, the device incorporates a Peak algorithm for 3D data construction. This algorithm combined with the intelligent Skip Scan function has reduced data acquisition times by 75%.

➔ **Olympus – www.olympus-ims.com**

Measurement of Effective and Flange Focal Length of Camera Lenses

With the OptiSpheric AF 500 INV Trioptics presents a measurement system that is specifically designed for the precise measurement of flange focal distance and effective focal length of camera lenses. With this instrument these parameters can be quickly and reproducibly measured – regardless of their physical length. Mounting lenses on the measurement instrument is additionally facilitated by the simple implementation of customer-specific sample receptacles. In addition, the system can also measure back focal length, radius and MTF for camera lenses with a length of up to 300 mm.

➔ **Trioptics – www.trioptics.com**

Automated X-ray Inspection of Casting Parts

The XRH RobotStar is a digital X-ray robot-system that allows an ultra-fast in-line inspection. The throughput can be increased by using a cluster of several systems and an innovative Automated Defect Recognition (ADR). The underlying principle is that a loading robot on the outside handles the incoming parts and distributes the inspected parts while the robot on the inside has a C-Arm with mounted X-ray components. The acquired images are automatically processed and checked for critical defects or other user-defined criteria. The patented system is ready for Industry 4.0.

➔ **Visiconsult – www.visiconsult.de**

Coordinate Measuring Machine for The Shop Floor

With the new SF 87 ShopFloor Coordinate Measuring Machine Wenzel has expanded its product portfolio with an entry-level system for the production environment. The brand-new SF 87 has all the attributes needed for a shop floor CMM, but benefits from an optimum measuring volume for this type of construction in relation to its footprint. Further efficiency gains can be achieved by using more powerful probes and optical sensors. A measuring volume of 800 x 700 x 700 (mm) was realized to be aligned with common sizes of metal cutting and forming machines.

➔ **Wenzel – www.wenzel-group.com**

Multi-sensor Measurement without Restrictions

A large combined measurement range can be achieved for multi-sensor measurements with ScopeCheck FB DZ machines, as for the smallest machine it is 425 x 500 x 350 mm with an image processing sensor and a conventional probe. The new system has compact dimensions and a low weight. The machine is sturdy, with good ambient vibration responsiveness. With the new transmitted light concept the glass table and transmitted light unit are easy to disassemble for the measurement of heavy workpieces. The machine can optionally be equipped with two independent sensor axes.

➔ **Werth Messtechnik – www.werth.de**

Twice as Fast and Twice as High-res

The new, advanced 3D sensor Zeiss Comet Pro AE, as the heart of the robotic optical 3D measuring system the Zeiss AIBox flex, makes modular at-line measurements even faster and more precise. This was made possible by countless technical improvements. The new fringe projector offers twice the available resolution, measuring speed and light intensity. With a transfer rate of 4.6 megapixels per second, the shortest measuring time is 1.9 seconds. Customers benefit not only from higher speed, the new system also impresses on account of its high flexibility, robustness, quality and ease of use.

➔ **Zeiss – www.zeiss.de**

WILEY

Meet the Winners at Vision on Tuesday

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A Cordial Invitation to the Award Ceremony

06.11.2018 – at 4:30 pm
At the Vision show
on the Wiley booth:
Foyer East Entrance,
booth E103.

www.inspect-award.com

Hyperspectral Machine Vision

Intelligent Automation Enables Automated Sorting for Difficult Applications

Hyperspectral imaging is an exciting new technology whose popularity is rapidly increasing. When combined with statistical machine learning algorithms and robotic actuators, hyperspectral imaging will revolutionize industrial sorting and quality control.

Hyperspectral imaging involves measuring high-resolution spectral data at every pixel in a two-dimensional image. In contrast, standard cameras provides three spectral data points at each pixel: red, green, and blue (called "RGB"). The viewer's brain inputs the mixture of these colors and interprets them as a unique color. At each pixel in a hyperspectral image, the materials' reflectance spectrum is a continuous curve with hundreds of spectral data points. Figure 1 shows an RGB image from aerial hyperspectral data of a farm, along with reflectance spectra from three regions in the scene.

Hyperspectral imaging is a combination of both spectroscopy and imaging. A standard spectrometer provides only one "pixel" per measurement – there is no imaging. A standard color camera only gives three broad spectral datapoints ("RGB") – there is no spectroscopy. Hyperspectral imaging provides both. The term "hyperspectral" refers to many spectral data points producing a near continuous spectrum, typically hundreds of spectral data points at each pixel.

Multispectral Imaging

A less expensive alternative technology is "multispectral imaging", which delivers a few spectral data points, typically between four and twelve, at each pixel. Figure 2 shows the same spectral data from figure 1, but reduced to a multispectral signal with four bands, similar to what early Landsat satellites measured. It is clear that hyperspectral data contains much more information than multispectral data, enabling more detailed analyses and robust classifications.

The value of hyperspectral imaging in automated sorting is suggested by the results of recent research at University of California at Davis. In this study hyperspectral data of Corymbia tree seeds (similar to Eucalyptus) was obtained, and then the seeds were planted. The seeds' viability was correlated with different reflectance spectra, shown in figure 3.

The red curve represents seeds that are alive, and the green curve represents seeds that are dead. Note the spectra are very similar in the visible spectral region (roughly 400-700 nm), and that spectral differences are only evident in the near-infrared (wavelengths > 700 nm), which is invisible to human eyes.

The Challenge of Similarity

Two categories of objects that are troublesome for conventional vision systems are materials with similar colors (such as seeds and husks), and materials that require infrared spectroscopy to differentiate (such as

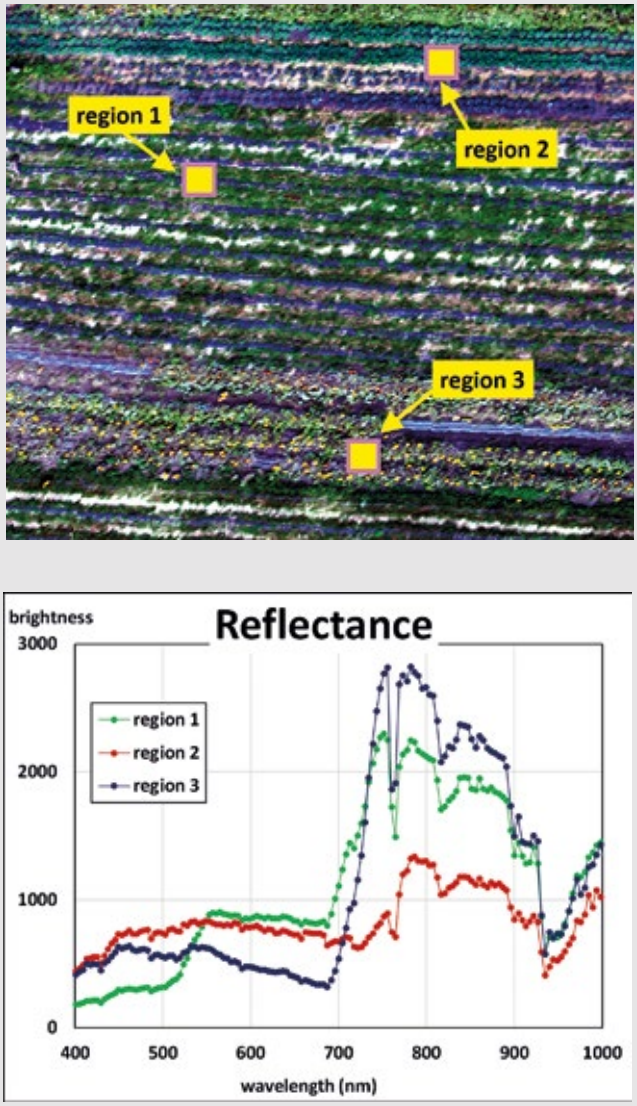

Fig. 1: True-color image from aerial hyperspectral data of a farm (image above), and reflectance spectra from the specified regions (graph below)

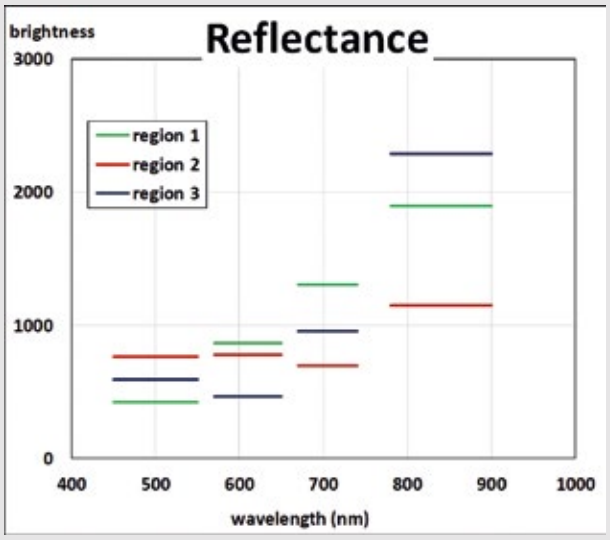

Fig. 2: Multispectral data of the same regions from the image in figure 1. Spectral bands correspond to those used in Landsat satellites.

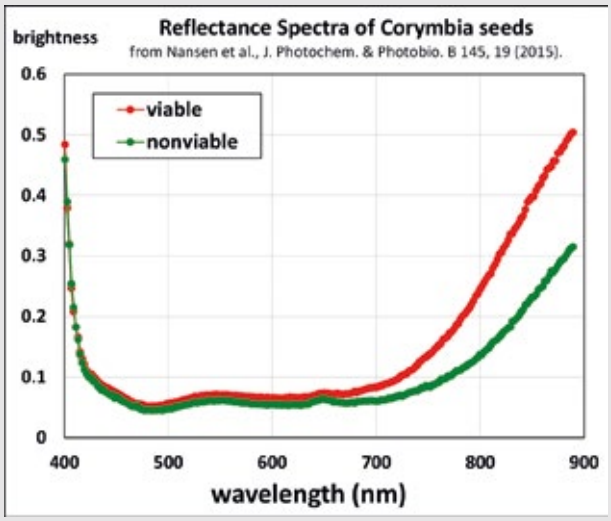

Fig. 3: Hyperspectral data of Corymbia seeds, showing a difference in reflectance correlated with seed viability

"The term "hyperspectral" refers to many spectral data points producing a near continuous spectrum, typically hundreds of spectral data points at each pixel."

plastics). When standard vision systems fail, these sorting tasks fall to humans, which are costly, slow, and prone to mistakes. Hyperspectral data, on the other hand, can be used to distinguish differences between similarly colored materials, and furthermore can access information outside the visible range, in both the infrared and ultraviolet.

Hyperspectral data, on the other hand, can be used to distinguish differences between similarly colored materials, and furthermore can access information outside the visible range, in both the infrared and ultraviolet. Real-time machine learning algorithms process the data in seconds and then transmit the information to actuators such as robotic arms, air-jets, and mechanical flippers to complete the sort.

Despite the clear advantage of providing more detailed data than conventional imaging systems, hyperspectral imaging is still in its infancy. Speed limitations have only recently been overcome for real-world applications, and much development is still required to make this technology widely installed. Moreover, the market is understandably skeptical, as real-world production facilities are not the place for incomplete technology or research projects. However, as the technology improves, previously intractable problems will be solved on large scales. Thus, the future of this exciting and colorful technology appears bright.

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Recycling Evolution

From Plastic Sorting to Process Analysis of Secondary Fuels

The recycling and the secondary use of waste as fuel are complex issues. While hyperspectral cameras support the plastic sorting process, the appropriate software tools enable quantitative hyperspectral analysis, thus transforming hyperspectral imaging technology into a measurement, monitoring and sorting system.

In Europe, the amount of plastics wastes produced amounts to about 25 million tonnes a year. On the average, no less than 37 kg plastic waste a year will be produced by each German, this amount being based on nothing else but packaging waste. Quite often these plastics will end up as micro-plastics in the air, in the soil and in the sea and thus in our foodstuffs. In order to counteract this adverse impact on our environment and our health, the European Union aims at circular economy in order to preserve resources as long as possible.

One step on this way is that of minimising one-way (disposable) plastics: All plastic packaging on the EU market is to be recyclable by 2030. The future energy goals of the European Union are defined as follows: a share of at least 27 % in renewable energies and an increase of energy efficiency by at least 27 % by 2030. In order to achieve these goals, however, it will be necessary to increase the demand for secondary raw materials and the use of high-grade recycled materials.

On the global recycling market, China's National Sword Policy must not be underestimated either. This policy comes up with laws about the import of waste to China that are becoming more and more stringent and additionally exerts pressure on recycling industry.

A Most Complex Topic

Recycling as well as secondary use of waste as fuels or as packaging materials is one of the most complex and most important topics of our time. If, for example, it is all about the high life cycle of high-quality final products made of plastics, ensuring purity of fractions in terms of their chemical composition as well as sorting of different plastics such as PET (polyethylene terephthalate), HDPE (high-density polyethylene), LDPE (low-density polyethylene), PP (polypropylene), PVC (polyvinyl chloride), PS (polystyrene), POM (polyoxymethylene), PA (polyamide), etc. according to colours are relevant factors.

This is not easy as the different polymers insufficiently differ in their colour, density and electrical properties, it will not be really possible only to separate them by using a colour camera, density sorting or by means of electrostatic sorting.

Hyperspectral camera systems operate in the wavelength range of 900 to 1700 nm and offer an ideal substitute or supplement to colour cameras. Because their wavelength range is beyond the visible light, i.e. in the infrared range, they make it possible to detect the chemical composition of different polymers without having to consider the effects of the visible colour. Due to the enormous opportunities yielded by this technology, EVK has been offering know-how in the fields of plastic sorting and quality assurance for many years and delivers solutions ranging from data acquisition to decision-making.

Hyperspectral Imaging Systems

EVK's Hyperspectral Imaging Systems operate according to the so-called push-broom principle. This means that recording will be done line by line, and an image in the traditional sense of the term will not be created until the velocity of motion of the object is coupled with line acquisition of the sensor. This helps to generate images that do not only have a local resolution of 320 pixels but also a spectral resolution of 258 wavelengths. It is true that this spectral resolution is quite high and leads to a big data volume. Nevertheless, the use of a line camera with integrated real-time evaluation makes it possible to achieve a full-frame rate of up to 500 Hz or, or, at a reduction of the spectral range, even to reach frequencies of more than 1 kHz. Thanks to the combination of the high frame rates with the wavelength range used it is possible to detect miniature objects such

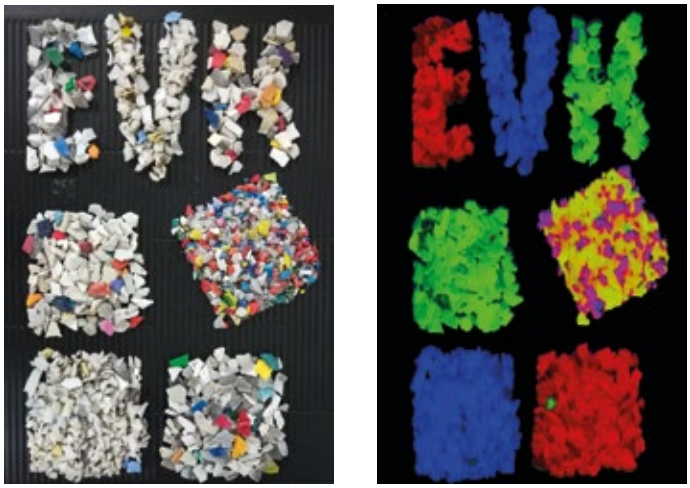

Fig. 1: On the left: Original photo of various plastic flakes; on the right: Plastic flakes that have been classified and visualised in a 24-bit RGB false-colour image.

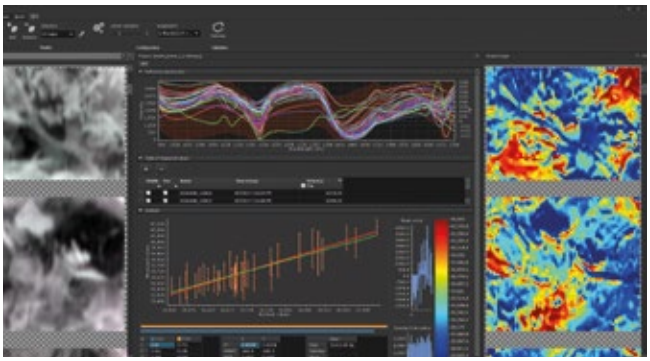

Fig. 2: Quantitative measurement of the net calorific value (NCV) of the bulk material: on the left: HSI input images in a spectrally averaged and standardised intensity; in the centre/top: sets of reference spectra as well as feature curve for the measurement of the net calorific value (green), table showing the measuring values, calibration function with data points as well as statistic process parameters of the measurement; on the right: The output image data as it is also shown as a stream with measuring values of the net calorific value that are scaled in false colours by the parameterised camera. The NCV Model reaches a precision (RMSEC – Root Mean Squares Error Calibration) of 1,681 kJ/g at a correlation (R2) of 0.903.

as plastic flakes and to classify them depending on their material. Therefore, different algorithms are available. These algorithms enable the visualization of classified materials in an RGB (Red Green Blue) false-colour image. The image is identically reproduced in the classified stream of the camera and makes it easy to detect individual foreign materials and impurities.

Quantitative Real-time Monitoring

Another example from the industry shows the problems with the reuse of secondary fuels. Out of 8.3 billion tonnes of annual plastic production in 2015, only 600 million tonnes were actually recycled, 800 million tonnes were burnt. Therefore, the reuse of plastic waste as secondary fuels is a contribution to a sustainable recycling policy in terms of environmental and economic policies. Thanks to the analysis of the materials to be burnt, it is possible to determine in advance how much material will need to be fed to the incineration process in order to achieve a stable process. This will enable good housekeeping with recoverable fuels and thus help to save the environment while increasing the economic efficiency of garbage incineration plants. In concrete terms, this means that the use of a quantitative hyperspectral analysis directly in-line can help to improve the economic efficiency of the line.

For this purpose, EVK has developed the analysis tool Sqalar, a solution that can be used for the quantitative real-time monitoring of material streams based on data analysis. Thanks to so-called quantitative chemical imaging (QCI), relevant measuring variables are acquired right in the line so that it will, if necessary, be possible to intervene in the ongoing process and change it. The reflection spectrum of the material used in this process will change proportionately to the occurrence of functional groups within the material. The big advantage is that it will be possible to identify a representative measuring value of such important process variables as humidity and the net and gross calorific values throughout the material stream in real time. Such an analysis of the overall stream will make it possible to make process control even more accurate and to assess different suppliers as well as the material qualities delivered by them.

Quantitative Analyses with HSI

In order to enable such a quantitative analysis using hyperspectral imaging (HSI), it will, first of all, be necessary to record several hyperspectral images of the product stream. Then specimens will be taken out of this material in a well-aimed manner and studied by means of methods based on reference analytics. Then the resulting reference values will be correlated to the fitting spectrums by means of multivariate data analysis. This will help to create a model that can be used to predict measuring values by using spectral data. Thus, HSI camera systems can, with the right know-how, be used to monitor the production of clinkers in cement plants. In this process, secondary fuels will be used to fire kilns. If the net calorific value of these secondary fuels is too low, there will be a critical drop in temperature: Therefore, the quality of the clinker will be reduced.

Up to now, specimens of these secondary fuels have only been studied by way of sampling and laboratory analysis. Yet as the material stream is so heterogeneous, and the amounts of specimens are too low, this does not lead to expressive results. Moreover, it should be borne in mind that such laboratory measurements cannot be done in real time and therefore highly depend on local fluctuations. Thanks to quantitative chemical imaging the process variables relevant to the production of cement, such as humidity or the net and gross calorific values, can be acquired quantitatively. The product stream as a whole can be monitored in real time. This is why the measurement won't be subject to any fluctuation due to insufficient sampling and re-adjustment can be done without delay.

Spectral Data Evaluation

For this kind of quantitative analysis based on HSI, several specimens out of the product stream will first be recorded and studied by way of reference analytics. Then the spectral image data will be evaluated by using Sqalar. The result of such a quantitative measurement of the net calorific value can be seen in figure 2. The correlation function of the reference values with the spectral data, which is shown here, as well as the resulting feature curve will be used to determine the net calorific value. In the camera stream subjected to final classification, the initial image data will be scaled on the basis of the measuring variables and shown in false colours. This enables quantification of the process variables.

As a result, the concrete application know-how of correct data processing and smart information management helps to turn the hyperspectral imaging technology into a measurement, monitoring and sorting system helping to improve the return on investment within a facility sustainably.

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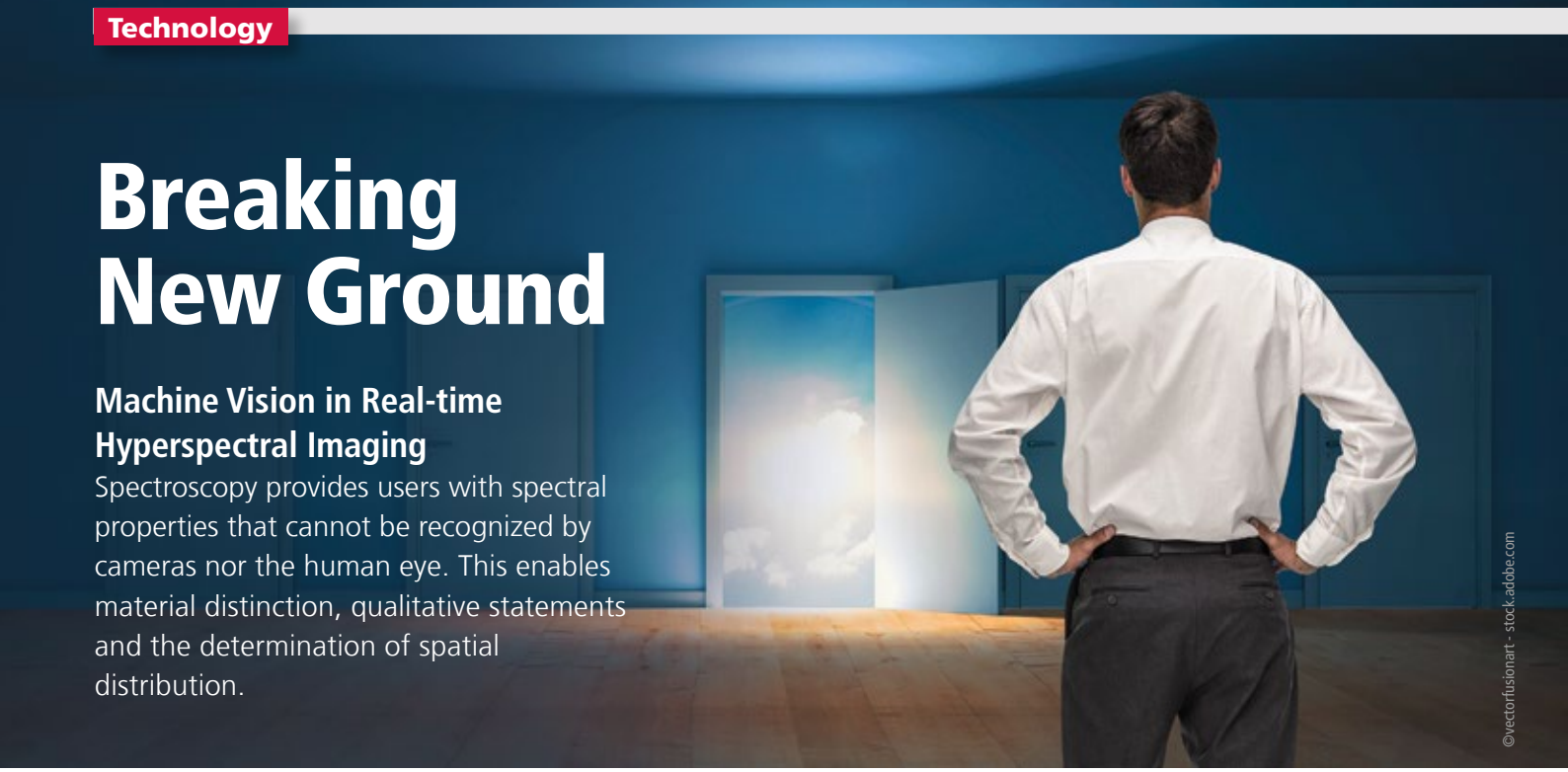


Breaking New Ground

Machine Vision in Real-time Hyperspectral Imaging

Spectroscopy provides users with spectral properties that cannot be recognized by cameras nor the human eye. This enables material distinction, qualitative statements and the determination of spatial distribution.

With the help of spectroscopy users can locate spectral properties that are not visible for traditional cameras nor the human eye. These properties are usually directly related to the optical characteristics of the analyzed surfaces. As every material has a different spectral signature the data therefore not only helps to distinguish between materials but also to make qualitative statements about the analyzed object. Moreover, spectral imaging enables the examination of the spatial distribution of different materials and of quality differences.

Breaking New Ground in Hyperspectral Imaging

When Cubert was founded in 2011, the company broke new ground in the field of hyperspectral imaging. They made it possible to acquire hyperspectral images within just moments, without the need to perform extensive pre-processing before working on the data as we know it from line scanners such as push-broom sensors.

One of the company´s major products is the hyperspectral snapshot camera FireflEye S185 that acquires a complete data cube within 1 ms. The camera's 125 spectral bands cover a wavelength range from 450 to 950 nm, i.e. the visible blue to the near infrared region.

Various Fields of Application

When looking at the applications hyperspectral cameras are used for there is a large variety. Precision farming, punctual disease identification and resource mapping are of increasing interest in agriculture and forestry. Mounted on a UAV, a hyperspectral camera quickly provides data that can easily be analyzed without the need for pre-processing.

Water quality monitoring, the documentation of land contamination, urban planning and soil composition are of high value for sustainability management. Throughout the last years, an increasing interest in industrial applications, such as material identification and surface analyses, can also be recognized. Answering the question what all of these different applications have in common the conclusion is that they are all about retrieving information from optical data.

Quantification, Qualification, and Classification

It is therefore a focus to distinguish between different materials and surfaces whenever the human eye or traditional camera technology are not able to do so. Spectral features might be too small to recognize, the information could be hidden in the near infrared range, or the human eye may simply be too slow for moving processes. Image classification techniques help to identify the differences and to quantify the results. In addition, material properties are important. Besides quantification there is also a high interest in the appropriate qualification of a product. An example is the automated estimation of the degree of ripeness in the food industry. It provides very important information as the industrial value of such products is directly linked to a high-quality standard. Using hyperspectral imaging for the monitoring and evaluation of industrial values can indeed support and even automate decisions, speed up processes and ultimately save money.

However, the step from providing a camera to a customer to finding an individual solution for his requirements is a big one. The setup of an appropriate software application for the retrieval of information from spectral data usually involves a lot of development, testing, evaluation, etc. This is in most cases very time-consuming, and developments often suffer a lack of expertise. The reasons for this

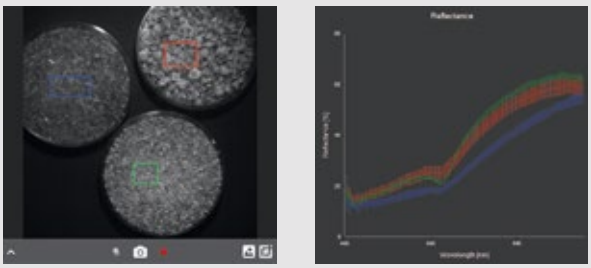


Fig. 1: Looking at the spectra it becomes clear that they resemble one another.

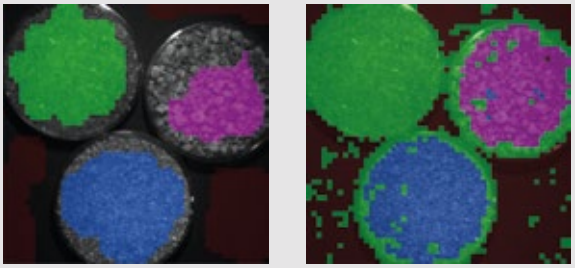


Fig. 2: The classification already works well in the first step.

Featured Technology

The hyperspectral camera FireflEye S185 uses a unique technology that establishes a fair balance between spatial and spectral resolution. The result is an imaging spectrometer with no need for scanning (such as push-broom sensors) or image combination after fast filter shifts. Cubert's technology provides clean hyperspectral images out of the box without any moving artifacts.

Besides the spectral camera that takes 2,500 spectra simultaneously, a panchromatic camera with a resolution of 1,000 x 1,000 pixels is also included, allowing the pan-sharpening of the live data for the quick identification of structural features for a deeper spectral analysis.

are sophisticated requirements like mathematics, statistics, remote sensing, optics, programming, and others.

Providing a Solution

Cubert is now able to support their customers in meeting these requirements. Thanks to their collaboration with PerClass BV, a software company that develops tools for the interpretation of spectral images and machine learning solutions, they can allow the user to (1) record spectral data, (2) use this data to create a statistical classifier for specific materials and (3) apply this classifier to the live data stream as a plugin to the Cubert Utils software – all of the steps within just three minutes. PerClass is a classification tool that is based on machine learning and involves state-of-the art classifiers such as support vector machine or random forest. With PerClass Mira, a GUI based on the perClass engine, the user requires no deep understanding of machine learning and classification techniques.

Real-Time Classification Using Machine Vision

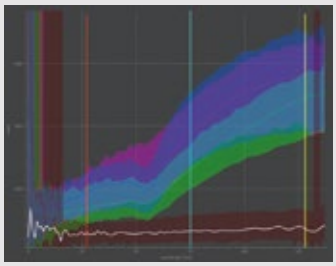
"In order to demonstrate the potential of the hyperspectral camera for machine vision applications we placed some samples of different herbs – chamomile, oregano, basil – on a rotary plate in our laboratory. The hyperspectral camera S185 was installed above the samples. Figure 1 shows the samples as seen by the camera (left). When taking a closer look at the spectra of the three different herbs (right) that correspond to the pixels bordered by the respective rectangles in the left image it turns out that the spectral reflectance is quite similar, challenging the classifier to separate the herbs," said Dr. Matthias Locherer, Cubert's Sales Director.

After exporting some of the images to the PerClass Mira interface the first step is training – realized by defining three classes for the herbs (plus one for the background) and simply drawing known pixels as corresponding labels within the image (fig. 2, left). Afterwards the model is trained and directly applied to the data on the basis of this reference information (fig. 2, right). The result shows that in this first attempt the classification works quite well, although some artifacts in form of falsely classified pixels still appear.

A simple second step to improve the model is to exclude some of the bands at the beginning as well as at the end of the wavelength region for the model search. This is done by re-defining the band start and end (fig. 3, left). The reason for this is that the bands in the rear wavelength regions of the camera are noisier due to the natural characteristics and sensitivity of silicon-based cameras. Removing those bands allows the model to perform with less error. Once the classifier delivers satisfying results it can easily be exported from the interface and integrated to the Cubert Utils software, where it is directly applied to the live data stream (fig. 3, right).

As a result, the classifier performance can be called satisfactory, especially when considering that it only took minutes to construct it. Most of the pixels are classified correctly (chamomile in purple, basil in blue, oregano in green and the background in dark red). The falsely classified pixels are mainly found in the border regions of the herb´s shells. This was to be expected as there was no class defined for these spectrally mixed pixels. The result can even be considered remarkable: When activating the rotary plate, the pixels are still classified correctly although the light conditions – such as the illumination angle for each pixel – instantly change.

This example shows the strong potential of hyperspectral snapshot cameras and how intelligent software solutions, for example in the area of machine vision, can be a valuable support for various kinds of applications, especially when working on live data.



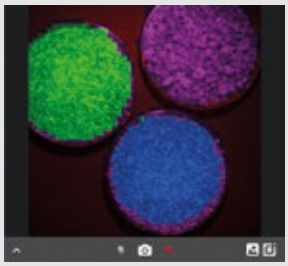


Fig. 3: The performance of the classifier can be considered very good.

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Vision 2018 Hall 1, Booth 1B17

Just Good Quality

Hyperspectral Imaging Ensures Consistent Food Quality

The ability to detect foreign materials along the inspection line is reasonably straightforward using legacy RGB camera systems. But the demand for higher inspection thoroughness means that technologies such as hyperspectral imaging are giving rise to new integrated advanced machine vision solutions.

When you open up a package of nuts or fruit snacks, you expect just good quality products inside. The presence of any kind of foreign material (nut shells, for example, or bits of stone or plastic) can be a disastrous outcome for any company. Consumer preference can plummet, and negative PR has a lasting effect. The same can be said for meat products, seafood, poultry, and anything else that demands a high degree of accurate inspection and quality control.

Improving Inspection

Hyperspectral imaging technology improves the ability to inspect and grade food products based on very particular characteristics. Kwok Wong, Headwall's Technology Director for Spectral Imaging Products, noted that "Traditional camera systems and humans can generally detect foreign materials in the stream that look different in the visible range, but they cannot consistently detect foreign materials or defective products that are similar in color to good products." Hyperspectral imaging sensors provide over 200 spectral bands of data tracing out/ measuring the spectral reflectance curve of every pixel in the image. This allows the identification of foreign materials and products not fit for consumption because each material has its own spectral signature that the sensor can detect.

The hyperspectral imaging sensor works in conjunction with spectral algorithms that not only detect foreign materials but can also "grade" and classify otherwise good products. Size, rot, color, and shape are other characteristics the sensor can be trained to detect. This allows companies to grade and sort products with a level of precision unobtainable from human inspectors or RGB camera systems. "The sensor has very high spectral and spatial resolution, so it can determine precisely what it sees and where it is on the inspection line," said Kwok.

Spectral Line Scanning

The basic technology behind hyperspectral imaging is called spectral line scanning, which depends on motion occurring (in this case, the inspection line) to build a 2D image. A Headwall hyperspectral imaging sensor comprises several components. First is a foreoptic lens, followed by a spectrograph that disperses the reflected light into its spectral components which are detected by a camera/focal plane array (FPA). The output of this system is a hyperspectral data cube comprising all the collected frames, each of which contains full spectral data for every pixel within the field of view. Sometimes, two sensors are used per line with the product being flipped in between to scan/ sort both sides of the product. Automated robotic systems are instructed to pick offending items off the line based on the very precise spatial data collected by the sensor.

One of the challenges of using spectral imaging in a production environment is the small number of photons from the scene that end up on each pixel of the focal plane array. The light from each scene pixel is spread out across many pixels on the focal plane to enable the hundreds of spectral bands. This high number of narrow spectral bands is why a hyperspectral imaging sensor can classify based

Algorithm-powered hyperspectral software provides rich data analytics to food inspection companies.

on many different variables as mentioned earlier. In addition, fast camera frame rates are necessary in fast belt-speed applications to avoid motion blur and to capture fine spatial resolution images that are processed producing ejection instructions being communicated to downstream robotics.

Beyond the Abilities of RGB Cameras

Obtaining very high spectral resolution data at high spatial resolution is something hyperspectral imaging sensors do that traditional RGB cameras cannot. The need for higher levels of discrimination and classification benefit from the hundreds of spectral bands rather than just three. Furthermore, these bands are very narrow and contiguous meaning that discrimination is precise since a full spectrum of data is collected for every spatial pixel.

Some of the technical characteristics of a hyperspectral imaging system can be positioned as benefits for this kind of inspection work. Systems with good low-light sensitivity, low read noise, good linearity especially at low light levels, and high frame rates allow line speeds to run very quickly while delivering a high degree of classification accuracy. This is particularly important with food inspection applications where accurate classification performance at high speeds is required.

Hyperspectral Sensors Excel in Food Inspection

A sensor with high dynamic range produces data with high fidelity in both the highly reflective (very bright) and very dark areas of the scene, resulting in accurate classification regardless of whether the sample is well illuminated or not (e.g. in shadow areas). Finally, having a high spatial pixel count means that the technology is suited to detect very small defective areas on products across a wide inspection line. Small defects (~0.5mm – 1mm) in nuts, berries, and other specialty food products can be detected, located and managed wherever they might be on an inspection line up to 1 m wide.

Overall, the same hyperspectral imaging technology that that is used for food inspection can also be used for other in-line applications. Plastics or metal recycling are two examples, where different spectral signatures can allow the system to finely differentiate and sort materials to achieve higher efficiency, value and profit.

In addition, hyperspectral imaging sensors can be designed to deliver identical performance from one unit to the next within a given application. This is an important distinction where food-inspection (and many other) applications are typically multiple-line installations, either in one facility or across several. Each deployment needs to behave and perform the same in what is called method transferability. A single set of spectral library and algorithm can then be used across these systems without re-calibration or adjustment to produce "identical" performance.

The ability of a hyperspectral sensor to "see" with exceptional spatial and spectral resolution is only part of the story. The other part involves using high-speed robotics to extricate anything not meeting the definition of "acceptable." As mentioned earlier, this can be an otherwise good product that has a grading specification slightly different than acceptable. The sensor's application software immediately communicates this information to downstream robotic handlers, which then know exactly what to pick (based on its spectral classification) and where it is on the line (its spatial position).

Is there payback for transitioning from a traditional RGB camera system to a hyperspectral-based one? Yes! In food inspection, otherwise good product is thrown away regularly because the ability to finely "grade" nuts or berries or plastics is missing with simple three-band RGB systems. Also, the risk of food contaminants and foreign material reaching the consumer is altogether very real. Consumer preference and shareholder value can plummet through negative PR associated with these occurrences.

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Vision 2018 Hall 1, Booth 1C31

Chii 2018

Established by the Industry, for the Industry

The third chii conference took place in Graz, Austria from 6 to 7 June 2018 at the Graz Congress building. Just like previous years, the cross-sectoral conference brought together the various stakeholder groups of hyperspectral imaging ranging from application engineers and instrument suppliers to R&D driven organizations and plant operators.

The program featured a dynamic mix of sales pitches, workshops and networking. This year, there were more than 160 registrations and finally 156 participants from 22 countries. 34 presentations were held in the Collaboration Forum. The chii-talks comprised 240 scheduled B2B-meetings. The training sessions were composed of two workshops with 9 lectures, plus a forum discussion for each workshop. Moreover, 17 exhibitors presented their latest technological developments in the field of hyperspectral imaging. At the evening of the first day, 124 participants joined the networking dinner during which new ideas were discussed till early morning.

For 2019, the organizers are planning something new and exciting: chii Academy will be taking place in Graz on May 23 and 24. The classic chii conference will be back in 2020. inspect international will inform you about the details well in advance.

www.chii2018.com

Fast, Small and Flexible Hyperspectral Cameras

The Specim FX Series is an industrial hyperspectral camera covering typical requirements such as high speed, robustness and reliability, and a sensible return of investment. They are easy to configure, maintain and service, enabling the machine vision industry to enhance its on-line quality control process by providing more accurate information. This saves both money and time and reduces the amount of unrecyclable waste. Line imaging push-broom is the only suitable technology that delivers reliable classification results in all industrial on-line applications. Due to their non-comparable spectral purity in each spatial pixel, the cameras give optimally co-registered results so that all spectral bands are measured simultaneously and from the same exact place. The Specim FX Series are the first commercial hyperspectral imaging instruments with factory loaded unified wavelength calibration that produces unit-to-unit compatible data output. This enables easy installation and replacement without a need for recalibration.

www.specim.fi

Hyperspectral LED Illumination System

Compared with traditional halogen light sources, Metaphases' LED hyperspectral lights generate less heat and don´t have negative effects on the inspected product, are more efficient using less power, and have a longer lifetime of 50,000+ hours. They are tunable to just the desired spectrums and optics friendly using a variety of optics to optimize light coverage area and power density. They offer full spectrum coverage and provide energy at all wavelengths in the continuous spectrum. Both curves are LED intensity normalized, however results will vary depending on the camera sensitivity. The lights offer a fine wavelength intensity adjustment via 0-10V control and can be used with cameras from different manufacturers, such as Specim, Resonon, Camlin Photonics, etc. They are also available with spectral curves to match hyperspectral cameras using Snap-shot or Mosaic style sensors.

www.metaphase-tech.com

Process Analyses with X-Ray Detector Technology

The on-line XRF analyzer line XRFline is suitable for detection of all elements with an atomic number higher than Potassium (in special cases maybe even below). The system uses state-of-the-art X-Ray detector technology. The performance of the Ketek Silicon Drift Detector (SDD) is characterized by a high count rate capability larger 1 Mcps, a good peak-to-background ratio, good energy resolution (~130 eV), and a wide energy range from 0.2 keV to 30 keV.

Paired with water cooled high power X-Ray tubes the full potential of the SDD´s can be exploited. Therefore, the sensitivity of the system is high enough to distinguish between different alloys of stainless steel, bronze, brass and more.

The resolution across the belt can be selected basically free (the smallest possible width is 25 mm) and will be adjusted for each system according to the size of the analyzed material stream. www.lla-instruments.com

High-speed SWIR Cameras for Hyperspectral Imaging

The camera series MV3-D640I-CL is based on the Sofradir Snake InGaAs image sensors with CMOS readout. This InGaAs sensor with a full well capacity (FWC) of 1.44 Me- is optimized for high dynamic range applications and a high signal-to-noise ratio (SNR). The camera has the CameraLink Base interface. It is focused on demanding applications in industrial image processing in the spectral range from 900 to 1700 nm. Due to the global shutter, even high-speed applications with exposure times in the µs-area are possible. The camera is available in two versions, either with CameraLink Base Interface or GigE Interface (GigEVision & GenICam). It offers opto-isolated I/Os for system integration and has a form factor of 60 x 60 mm. The camera offers the configuration of up to 256 regions of interest (ROI) for hypersprectral imaging, and the reduction of the ROI in x- and y-direction increases the frame rate.

http://www.photonfocus.com

Hyperspectral Imaging Made Easy

Prediktera´s software breeze makes it easy to collect and analyze hyperspectral images and to develop and run routine applications in real-time, even if one is not an expert. It works by simply scanning the surface of an object, and within a few seconds the software will provide both spatial and chemical information. With the new product offering breeze runtime the ease of use and high performance of breeze are brought to embedded real-time solutions for OEMs and machine integrators. Pairing the experience in hyperspectral image analysis with the dynamic features of the software and adding a real-time API, time-to-market for the implementation of chemical imaging in industry solutions is reduced. Objects can be classified and quantified in real-time, and with advanced object identification and spatial analysis features the further processing of the scanned objects is simplified.

www.prediktera.com

Bitter Almond Sorting

Thanks to Chemical Imaging Technology (CIT), the Sherlock Air system enables qualitative in-line sorting which, in contrast to time-consuming lab analysis, is done in real-time. The analysis of the entire near-infrared spectrum allows the chemical composition of objects to be analyzed in-line and in real-time, irrespective of color, shape, surface or specific weight, and dealt with on the spot. This enables outstanding recognition and removal of foreign bodies and visible defects as well as those that have hitherto been invisible to the naked eye. Precisely controlled high-speed air valves remove over 50% of the worst defects. A new software platform provides any desired combination of high-resolution 4 K cameras and sensor fusion, shape recognition, sizing and the latest machine learning algorithms. Sherlock Air meets the high standards of hygienic design and can be used for all foodstuffs in either wet or dry processes. For example, the system can be used for sorting almonds that naturally come in (in certain quantities toxic) bitter and sweet versions. www.insort.at

The Rise of SWIR

SWIR Spectral Imaging Enables a New Level of Analysis for Industrial Applications

Significant advances in the performance and costs of InGaAs detectors support the rise of SWIR Spectral Imaging. Part of a new generation of machine vision systems, it provides efficient sorting and control suitable for most industries.

Continuous developments in detector technology have enabled major improvements of imaging systems which, in turn, allow significant progress in the field of process control and industrial sorting. In particular, the ability to detect light outside of the visible spectrum has been a key to overcoming new challenges by gathering additional data that had never been available to the naked eye, nor to traditional CMOS or CCD image sensors.

SWIR

One area of special interest for industrial machine vision is Short-Wave Infrared (SWIR) that includes wavelengths located just beyond the reach of the human eye – roughly 700 nm – and up to 3 µm. Light in this domain is mainly reflective in a similar fashion to visible light, however, there are key differences caused by strong absorption peaks of certain wavelengths by molecular bonds such as C-H, O-H and N-H. This makes SWIR ideal to detect water and identify organic materials using reflective spectroscopy techniques.

Amongst these systems, spectral imaging cameras have the ability to collect both spectral and spatial information and create the so-called datacube that can be exploited to identify materials based on their reflectance spectrum. Spectral Imaging in SWIR has been used for quite some time in high-end systems designed for science applications such as earth observation and astronomy. These systems have been using Mercury-Cadmium-Telluride (MCT) detectors that offer a wide spectral response between 800 nm and 2.5 µm. On the other hand, MCT material can only operate in SWIR below 200 K (-73°C), thus these detectors need to make use of expensive cryocoolers or multi-stage Peltier coolers.

InGaAs

More recently, the emergence of the Indium Gallium Arsenide (InGaAs) technology as an alternative to MCT has enabled spectral imaging in SWIR to be considered for applications such as Industrial inspection. InGaAs has a narrower response covering wavelengths from 900 to 1700 nm with high quantum efficiency in excess of 70 %. InGaAs material has lower intrinsic noise figures and can operate at (or close to) ambient temperature resulting in more compact and affordable detectors that become compatible with the requirements of industrial applications.

The first practical examples of SWIR's use for industrial sorting are now maturing as systems are being deployed in volume for applications such as:

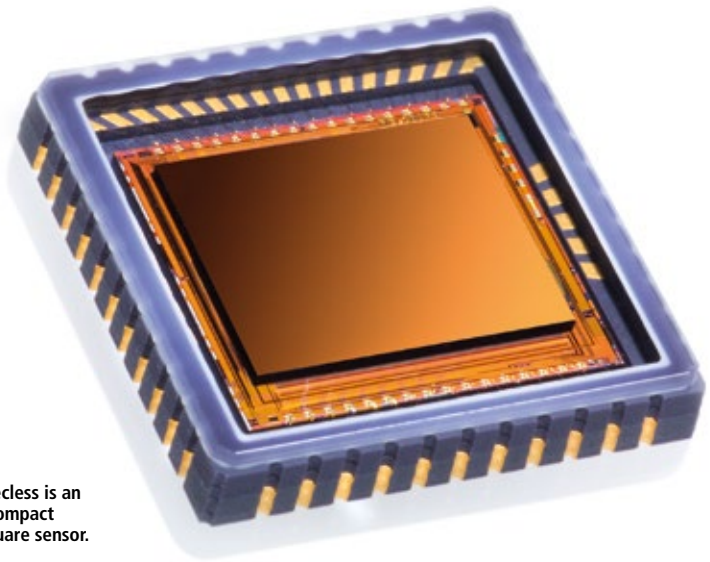
- identification of the main types of plastic for recycling;
- detection of moisture; acidity and sugar content assessment in fruits or vegetable;
- bone residues detection; proteins, fat or collagen quantification in fish or meat;
- infection and diseases detection in cereals;
- quality control in the pharmaceutical industry.

In these applications, the analysis of SWIR datacubes collected by spectral cameras allows the user to identify materials in-line, typically on a conveyor belt. In addition to simply sorting out elements that would not meet the expectations, this data provides statistical information on the quality of the production flow. This can allow for 100 % of the elements to be screened and provides instant results without the need for the destruction of samples and laboratory analysis.

Selecting the Right SWIR Detectors for Spectral Cameras

In order to offer the appropriate level of detection performance, spectral cameras must be compliant with the requirements of the target application. Most of these specifications are directly related to the detector implemented in the system, so selecting the right sensor option is critical for the success of the inspection process. Key considerations for selecting a SWIR detector for a spectral camera include:

- Spectral response: The most relevant absorption peaks of the elements that will be monitored by the camera need to be included in the response spectrum of the detector. Traditional InGaAs covers 900 to 1700 nm which includes wavelengths relevant to the majority of industrial applications. Extended InGaAs is also available but sacrifices noise figures as a result of higher constraints on the detection layer and it comes at a higher price. Cooled technologies such as MCT or T2SL offer an even wider response going up to 2.5 µm, however they are significantly more expensive and only relevant to high-end applications.
- Resolution: In a Spectral Camera, the detector format can impact both the spectral and spatial resolution. A sufficient resolution is required to detect small features across a wide field of view, but on the other hand larger detectors are simply more expensive. With current InGaAs detectors, the VGA format (640 x 512 pixels) seems to prevail as the best compromise between cost and resolution.
- Frame rate: Detectors and cameras that target industrial applications need to achieve a high frame rate in order to be compatible with the speed of conveyor belts. Limiting the throughput of the industrial systems is simply not acceptable, so faster detectors will have more chances to meet the requirements of in-line applications.
- Noise characteristics: The Photon flow in SWIR is lower than it is in other light domains, so the detector noise characteristics are even more critical. Both readout noise (generated by the readout circuitry) and dark noise (generated by the detection layer) need to be carefully considered in order to obtain a good signal-to-noise ratio which is critical to achieving efficient sorting.
- Image quality: Because of the complex process of manufacturing SWIR detectors, the number of bad pixels is generally higher, and the uniformity is lower than that of visible sensors. These imperfections need to be corrected by image processing and create the risk of lacking information.
- Export control limitations: Most Infrared detectors are considered sensitive components from an export perspective, so close attention needs to be paid to this aspect when selecting the right option. End use restrictions for certain detectors will impact both the camera and the system integrator and can be market-limiting.



Snake SW Tecless is an extremely compact 16.5 mm square sensor.

Another aspect that plays a significant role with InGaAs detectors is cost since this technology remains more expensive than visible image sensors due to the higher complexity of component manufacturing process. The recent increase in the production volumes coupled with continuous process ameliorations have made the detectors more affordable.

New Generation Detectors

Improvements of the detection of material purity along with better readout designs have enabled noise reduction down to a point where cooling only becomes necessary under specific operating conditions. Therefore, it has become possible to integrate even more cost-effective solutions such as the new Sofradir Snake SW Tecless, an extremely compact 16.5 mm square sensor. This detector delivers a high frame rate of 300 FPS with VGA format as well as industry-leading noise and image quality performance. Uncooled InGaAs detectors such as the Snake SW Tecless are expected to fuel the growth of SWIR spectral imaging for industrial applications in the years to come.

The significant advances in performance and cost of the latest InGaAs detectors are supporting the rise of SWIR spectral imaging that enables a new level of analysis for industrial applications. This new generation of machine vision systems provides efficient sorting and control suitable for most industries. This will support product quality improvements particularly applicable to organic materials such as food products, plastics, textiles as well as pharmaceutical and chemical compounds.

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Vision 2018 Hall 1, Booth 1E82

Snapshot multispectral camera demonstrator

Snapshot Multispectral Imaging

Customized Multispectral Analysis Tool for Advanced Object Classification

A multispectral imaging concept based on a multi-aperture system approach using a customized microlens array combined with a slanted continuously variable bandpass filter and a silicon-based image sensor helps to overcome the restrictions of scanning techniques or wafer-level coated detectors.

Hyperspectral and multispectral imaging have been used for a couple of decades in applications such as satellite imaging, air reconnaissance and other not overly price sensitive markets. The advent of alternative approaches makes spectral imaging attractive for volume and consumer markets, for example cancer detection, precision farming with unmanned aerial vehicles (UAV) or directly at the plant, or food testing in supermarkets. Alternative approaches comprise wafer-level coated sensors with fixed wavelength bandpass filters. Thin film coatings on glass substrates that can be patterned during deposition (in situ), or by using a photolithographic process over the coating to block the addition or subtraction of materials deposited on the substrate surface are also common. These micro-patterning techniques allow filters in a 2D mosaic structure (suited for the snapshot technique, i.e. acquisition of the hyperspectral data cube with only one camera exposure).

A Smart Combination

A novel snapshot multispectral camera with high spectral performance and high spatial resolution was achieved by combining a micro lens array imaging system by German Fraunhofer IOF and a continuously variable bandpass filter by Danish Delta Optical Thin Film. The continuously variable bandpass filters (CVBPF) developed and manufactured by Delta Optical Thin Film offer high transmission and are fully blocked in the light-sensitive wavelength range of silicon-based detectors. The combination of CVBPFs with silicon detectors (fig. 2) allows the design of compact, robust and affordable spectral imaging detectors that offer several advantages and benefits over conventional approaches:

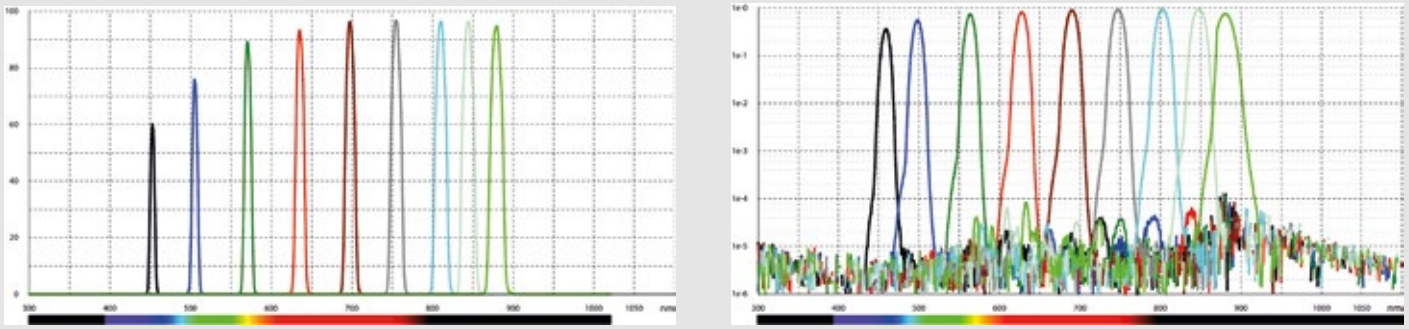

Fig. 1: Transmission and blocking characteristics of the Continuously Variable Bandpass Filter

- huge aperture compared with grating and prism;
- higher transmission than grating and prism;
- short measurement time;
- high suppression of stray light;
- excellent signal to background ratio;
- 3D and snapshot capability.

Figure 1 shows the transmission characteristics of a CVBPF that covers a centre wavelength range in VIS/NIR with a bandwidth of approximately 2 % of its centre wavelength. In a wide wavelength range, the transmission is higher than 90 %. But even more important than the peak transmission all undesired radiation from 200 to 1150 nm is suppressed better than OD4.

Comparison with Grating and Prism-based Systems

Due to the diffractive nature of gratings or prims, a slit is needed to obtain high spectral resolution. The spectral information along a narrow line of the object is imaged through the slit and spread out into one dimension of the imaging sensor. The other dimension is spatial. The second spatial dimension is built by push broom scanning. This inherently makes such systems incapable of snapshot acquisition.

Comparison with Wafer-level Coated Detectors

Wafer-level coated detectors can be produced with arbitrary filter patterns. This makes snapshot acquisition possible. In this case, the sensor is coated with a 2D pattern of bandpass filters with different but constant centre wavelengths. The snapshot capability of course comes at the cost of reduced spatial resolution. Another typical tradeoff of coating at wafer level is the limited spectral complexity of the filters.

Snapshot Multispectral Camera

In order to overcome the restrictions of using scanning techniques or wafer-level coated detectors, Fraunhofer IOF Jena proposes a multispectral imaging concept based on a multi-aperture system approach using a customized microlens array (MLA) combined with a slanted CVBPF and a silicon-based image sensor (fig. 3). In addition, a tailored baffle array is utilized for preventing optical crosstalk between adjacent optical channels. A customized multispectral analysis tool features the capabilities for advanced object classification.

Design and Fabrication

The main advantage of choosing a microoptical imaging system in combination with a CVBPF is the simultaneous capturing of spectral and spatial information in a single shot due to distinct spectral coded channels. The multi-aperture principle allows a degree of freedom between the spectral and spatial sampling according to the constraints of the CVBPF and the size of the image sensor. The number of spectral channels is therefore equal to the number of microlenses. As a proof of concept, the optical design of the MLA employs a single microlens surface. The optimization yields the system parameters that can be seen in table 1.

The CVBPF is slightly rotated around the optical axis with respect to the MLA in order to achieve a linear spectral sampling over the extended spectral range.

The ultra-compact microoptical system comprises microlenses in an array within diameters and sag heights in the

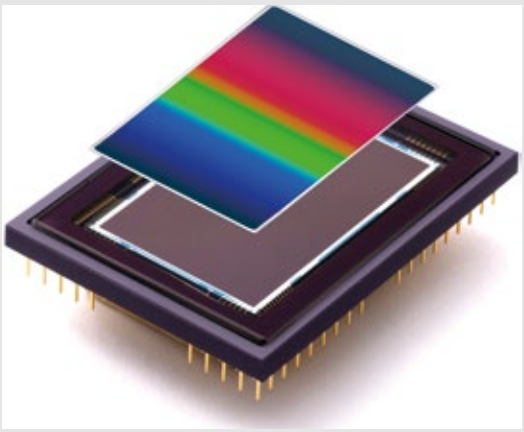

Fig. 2: Hyperspectral Imaging detector based on a Continuously Variable Bandpass Filter

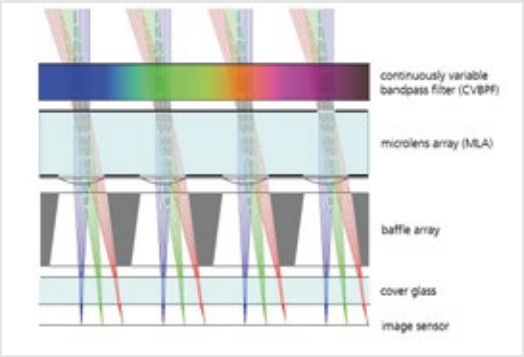

Fig. 3: Microoptical system concept for snapshot multispectral imaging

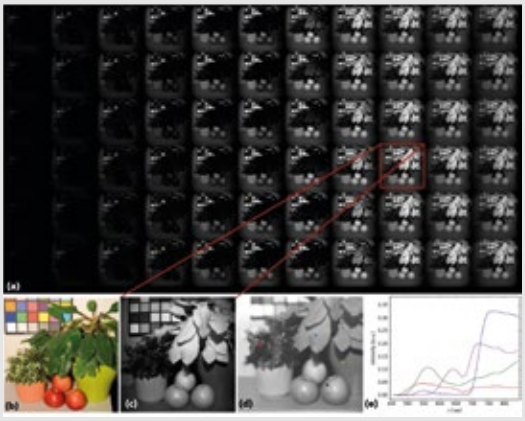

Fig. 4: a) Captured raw image of a scene seen in (b) of two plants (left artificial, right natural), apples and a color checker board in the background.
b) Photograph of the scene with a standard RGB camera.
c) Sub image of one spectral channel.
d) Averaged image over all 66 channels.
e) Smoothed spectra of four selected spatial positions.

Tab. 1: Overview of system parameters of the snapshot multispectral camera

system parameter	value
channels	11x6 (on Cartesian grid)
optical system length	7.2 mm
f-number (F/#)	7
field of view (FOV)	68° (diagonal)
image resolution	400 x 400 pixels (per channel)
spectral range	450-850 nm
spectral sampling	~ 6 nm (linear)

range of hundreds of micrometers. Hence, the fabrication of the MLA was performed by state-of-the-art wafer-level-optics technologies. A spherical microlens master is fabricated by UV lithography and reflow of photoresist. A replication tool is created and used for molding the final lens elements. The CVBPF, the MLA and the baffle array were mounted in a mechanical holder, actively aligned to the image sensor and fixed to the housing. The snapshot multispectral camera demonstrator has an overall size of only 60 x 60 x 28 mm³.

Calibration and Experimental Results

The spectral response of each individual pixel depends on the bandwidth of the CVBPF and the angle of incidence on the filter. A spectral calibration corrects these effects using a tunable light source. The multispectral camera enables the snapshot acquisition of 66 spectral channels with a linear spectral sampling of approximately 6 nm over a wavelength range of 450 to 850 nm with a spectral resolution between 10 and 16 nm. In addition, an object distance depended spatial calibration of the channels provides an accurate overlay of the individual sub images in the data cube.

Figure 4a illustrates the raw image of an extended scene in the lab and in comparison, an image captured with a standard RGB camera (fig. 4b). Due to the short focal length of the microlenses, the imaging module comprises a large depth of field and therefore every object in the sub image is in focus (fig. 4c). Our custom-developed software tool allows for a comprehensive analysis of spectra of objects in the scene as seen in figure 4d/e. For example, four processed and corrected spectra provide detailed object information, which constitutes the basis for an advanced object classification.

The camera demonstrator combines state of the art micro-optical manufacturing methods and a multi-aperture imaging principle with a commercial CVBPF. It enables the realization of highly compact and cost-efficient devices, capable of capturing spectrally resolved, extended object fields in a single shot with high resolution. Moreover, the proposed system concept provides a high flexibility with respect to spatial and spectral resolution by tailoring the number of spatial and spectral channels. The prospective fields of application of the developed system include environmental and agriculture monitoring, industrial surveillance and sorting, as well as biomedical imaging.

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inspect Buyers Guide 2019 – the official Buyers Guide of the EMVA

The **inspect Buyers Guide** is the official Buyers Guide of the EMVA (European Machine Vision Association). It is the first published European reference for components, products, systems and services for machine vision and optical metrology.

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Planet Plastic?

The Challenges and Importance of Plastics Recycling

Plastic has both become a technology absolutely inseparable from how we live our lives today, but at the same time a massive problem for our environment. Plastics sorting for proper recycling improves with better imaging modalities and machine learning.

One of the things that makes plastic waste different from other kinds of waste is that it is very difficult to do anything else with it. With plastics recycling, there is usually only a single re-use. And then they are thrown into the landfill. Or the ocean. Out of all of our historical plastic, only about 9 % has ever been recycled. Right now, only about four percent of all plastic is recycled, compared to 34 % of paper, 22 % of glass, and 30 % of metals. And yet there are opportunities for imaging to show us new solutions.

The Right Kind of Plastic

We've seen how imaging systems are improving how we recycle and even how imaging technologies like Lidar are helping to clean up the plastic in oceans. One of the problems is that the term "plastic" actually describes a wide variety of resins or polymers with different characteristics and uses. Polymers aren't often used in their pure forms – they are usually mixed with additives (including colors) to form more useful materials. The compounded product is generally termed a "plastic." Polymers can be classified in many ways, based on how they are developed and perform. When it comes to what we consider plastics, there are two kinds of polymers that become most relevant for sorting plastics:

Thermoset polymers undergo a chemical change when they are heated, creating a three-dimensional network of bonds or cross-links. After they are heated and formed, these molecules cannot be re-heated and re-formed – they are more likely to char but retain their strength and shape. This makes thermoset plastics ideal for heat-resistant products like insulation and car parts. Examples of thermosetting plastics include phenolic resins, amino resins, polyester resins, silicon resins, epoxy resins, and polyurethanes.

Thermoplastic polymers can be heated and formed, then heated and formed again and again. The shapes of the polymer molecules are generally linear or slightly branched. Examples of thermoplastics include polyvinyl chloride (PVC), polystyrene, and nylons. Their molecules can flow under pressure when heated above their melting point. Because of this, thermoplastics are ideally 100 % recyclable – they can be repeatedly melted and remolded into new products.

Identification: The Fine Line Between Disaster and Efficiency

But just because thermoplastics can all be recycled, doesn't mean that the process is the same. For example, polyvinyl chloride (PVC) bottles are hard to tell apart from Polyethylene Terephthalate (PET) bottles. Both plastics are common, but PET make up 97 % of all plastic bottles. And one stray PVC bottle in a recycling melt of 10,000 PET bottles can ruin the entire batch. Proper sorting is absolutely vital to the success of the entire enterprise. Equipment to sort plastics is being developed, but with such high stakes and

low margins for error, recyclers are often still sorting plastics by hand. That's expensive and complicated, leading to recycling workers suffering high rates of turnover and unsafe working conditions.

There are six different types of plastic resins that are commonly used to package household products. Yet, plastic consumer goods fall into the 7th category and are not usually collected. Plastic tarps, pipes, toys, computer keyboards, all use plastics that do not fit into the numbering system that identifies plastics used in consumer containers. Within this group, there are actually thousands of different varieties of plastic resins or mixtures of resins, developed for very specific application needs.

Until recently, no one has entered the business of collecting these plastics because there was no systematic way to identify them. Recycling plants can reduce costs and improve production quality with efficient machine-based identification and sorting methods. Spectral information can be used for real-time material identification, including differentiating between different types of plastic, in different conditions, and identifying recyclable plastics, glass, and metals.

Visible Spectrum Sorting

Visible spectrum sorting essentially does what the human eye can do, separating colored polymers or labels. Area and line scan cameras can be used to sort recyclable materials by color and shape, separate different color plastics, and to distinguish between recyclable and ceramic glass. The visible spectrum cannot be used to separate plastic by resin type unless the material is visually changed (e.g. by adding a colorant).

Near-Infrared/Short-Wave Infrared Sorting

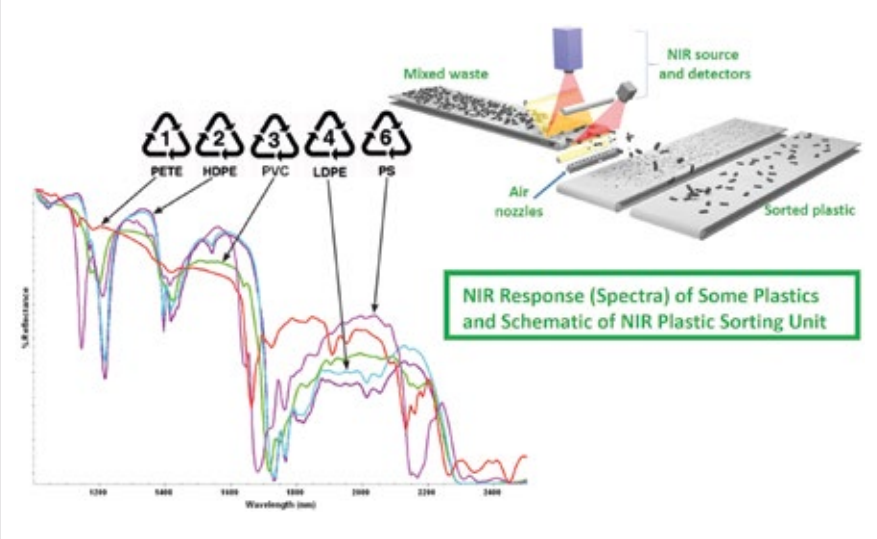
Both SWIR and NIR sensors can go deeper, identifying different recyclable plastics. The sensing system is typically an imaging system that can pinpoint plastics on a conveyor belt. IR radiation from a source along the conveyor penetrates plastic objects as they move by and a sensor measures their unique "fingerprint" response. NIR imaging could even be used to separate all plastics in categories 1 to 7 but currently may be considered cost-prohibitive for rarer materials. In a real recycling work stream, other imaging materials are needed to prevent contamination: While NIR is used extensively to separate HDPE and PET containers, it can't

While different imaging modalities can make fine differentiations between types of plastic, there is still a lot of manual sorting and automatic resorting going on to minimize expensive errors.

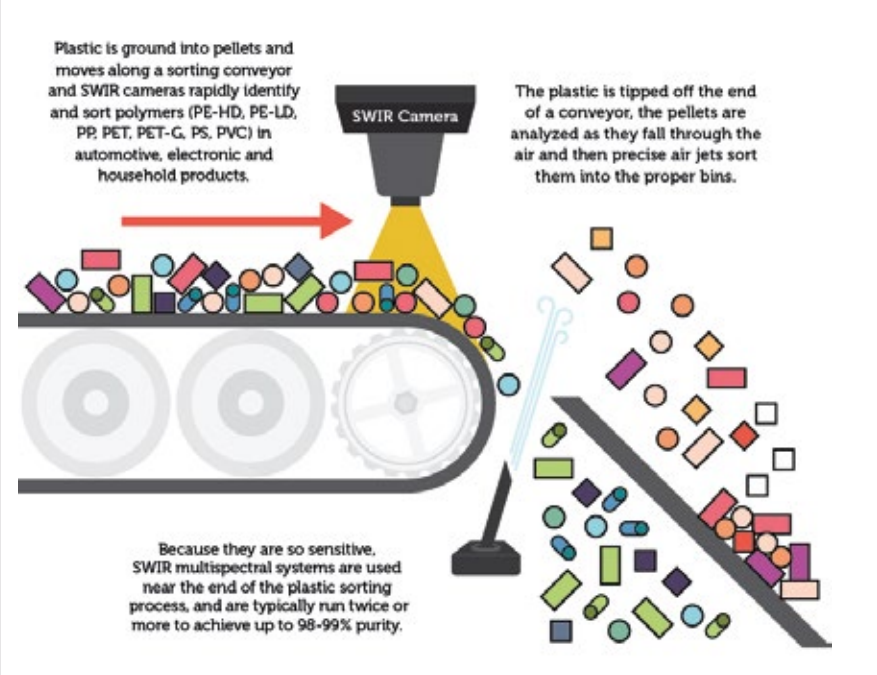
"see" glass or metal because those materials' molecular structure doesn't "vibrate" enough to be recognized.

X-ray Sorting

Imaging plastics at this elemental level can detect heavy elements, toxic substances, and specific atoms among plastics that otherwise look the same as those that are safe to recycle. X-ray imaging is also effective for distinguishing PVC containers – PVC contains chlorine, which gives a unique X-ray fluorescence response. Because it works at



Polymer sorting process



Vision system for plastics recycling

such a precise level, it has been useful for sorting extremely dirty bottles or containers with a lot of labelling – situations where infrared would be "confused." Still, x-ray can be an expensive and complicated imaging modality to employ. X-ray systems involve high energy and require effective shielding to protect workers, making NIR much more popular.

Hyperspectral Sorting

This kind of imaging can be helpful for separating plastics from non-plastics. The subtle differences between the hydrocarbons in office paper, newspaper, and cardboard are only detectable beyond standard SWIR imaging. Hyperspectral imaging systems can be used for other difficult-to-sort recyclable materials, such as crushed electronic scrap.

The applications of hyperspectral imaging are expanding though, and new technologies are making it possible to create flexible machine vision systems. While mechanical design, illumination, interfaces, and image processing used to be the major reasons why engineers used to avoid hyperspectral imaging, today it's a reasonable choice for some applications. Hyperspectral imaging has become a comparatively reliable and low-cost answer to something that was once very difficult – recognizing impurities in plastics that rendered them "un-recyclable."

Artificial Intelligence: Future Solutions at Scale

While these imaging modalities can make fine differentiations between types of plastic, there is still a lot of manual sorting and automatic resorting going on to minimize expensive errors. This has motivated several companies to look at bringing machine learning and artificial intelligence to this complicated sorting task.

The downside is that the contents of every single recycling bin in the world is a jumbled mess. The upside is that there is a lot of it. What data scientist or AI developer wouldn't want to work with a sample size of a few trillion?

One of the first companies to get into AI-driven waste sorting was ZenRobotics. Their system used a combination of computer vision, machine learning, and artificial intelligence (AI) to run picking and sorting robots. Multiple recycling stations were tied together in a neural network, increasing the sample sizes and how quickly the AI could learn from a combination of metal sensors, 3D laser cameras and spectroscopic cameras.

A Job Better Suited for Robots

More recently, a pilot collaboration by the Carton Council and two Denver-based companies, AMP Robotics and Alpine Waste & Recycling, produced Clarke, a recycling robot that uses AI to identify food and beverage cartons to separate them from the rest of the recycling workstream.

According to Resource Recycling, Clarke uses an off-the-shelf robot that's been in use for two decades in other industries. Clarke was first installed in 2016, but with constant improvement can now sort approximately 60 cartons per minute with near perfect accuracy. The Clarke AI has learned to recognize images from the cartons including logos and package printing, improving with each round of sorting.

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Vision 2018 Hall 1, Booth 1F62

Teledyne Dalsa to Unveil Breakthrough Imaging at Vision 2018

Teledyne Dalsa will unveil a host of new products at the Vision show, including three industry firsts – the first 5 GigE area camera, a multi-line CMOS line scan camera, and a multi-array CMOS TDI camera that deliver unmatched performance. Teledyne Dalsa's new Linea ML 8k and 16k cameras offer high speed and high-resolution mono, color and multispectral imaging. These multi-line CMOS cameras will transform the way line scan cameras are used, offering options for monochrome/HDR, color, multispectral, and polarization imaging for a growing number of machine vision applications. Independent start and stop of integration for each array allows versatile illumination configurations in a single scan using pulsed LED lighting technologies. The new Linea HS 16k camera is based on the latest charge domain CMOS TDI technology. The multi-array TDI sensor enables high speed multi-field imaging where brightfield, darkfield, and backlit images can be captured in a single scan. Both Linea ML and HS run at a maximum line rate of 300kHz with a Camera Link HS interface using fiber optic cables. The next gen Camera Link HS fiber interface is ideal for the most demanding applications that require high throughput, long cable length, and immunity to electromagnetic radiation in industrial environments. The company is also expanding its Genie Nano camera series with eight new 5 Gigabit Ethernet models. A first in the market, the newest Genie Nano models offer reliable high-resolution, high-speed inspection for existing GigE machine vision systems and are built around the industry's best performing CMOS image sensors from Sony. The monochrome and color 5-Gigabit models offer resolutions from 3.2Mpixels to 12Mpixels and Teledyne's award-winning TurboDrive technology. These new Genie Nano models feature the brand new 5GBase-T link speed.

www.teledynedalsa.com

Vision 2018 Hall 1, Booth 1F62

New Kowa 1.1" 12MP Lens Series Optimized for Sony Sensors

Kowa has released a new lens series for 12MP cameras with a 1.1" chip size and a pixel size of 3.45µm. The new FC series is optimized to fit the micro lenses of the new Sony sensors IMX253 and IMX304, so that unwanted shading on the sensor is prevented. The lenses are also wide-band coated which effectively decreases glare and reflection and produces a high transmission from the visible to the NIR wavelength. The focal lengths 8.5mm, 16mm, 25mm and 35mm are already on sale. The focal lengths 6.5 mm, 12 mm and 50 mm will follow in January 2019.

The new Kowa C-mount lens series is designed for use in industrial environments: the 1.1" optics are compact, robust and temperature resistant.

www.kowa-lenses.com

Vision 2018 Hall 1, Booth 1I62

CXP-12 in Sight

There has been a lot of talk throughout 2018 about the new CoaXPress 2.0. standard. It is often referred to CXP-12, reflecting the data rates of 12.5 Gbps per link. This effectively increases the throughput of the four-link camera to approximately 5GB of data per second. For some customers, this can be overkill, while other data hungry customers are asking when the next iteration will be coming down the pipe.

BitFlow, like some other frame grabber and camera companies, is working on a CXP-12 solution. This is because there is a lack of cameras on the market to support this standard and there are a few prototype grabbers out there. Launch of a product is intended at the Vision Show in Stuttgart. However, what really has the industry buzzing is the advent of the single link CXP-12 solution.

In Spring 2017, BitFlow released the Aon CXP single link frame grabber. This board is a half sized, (optional) low profile frame grabber

capable of 6.25 Gbps, which equates to close to 600 MB/S. In effect, this is 40% quicker than USB3 Vision, and no issue with requiring active cabling over a distance of 3 m or so. It's six times quicker than a GigE solution and comes without the interrupts that you can have over these two interfaces. Because the BitFlow boards use zero CPU cycles during data acquisition, the CPU power can be focused on the data that is streaming in to the memory for processing.

With the new CXP-12, a single link solution would increase this data rate to 1.2 GB/S which introduces a competitor to the expensive and limited distance dual cable Camera Link solution. This data rate is over 40% quicker than the 850 MB/S that Camera Link 80-bit (deca mode) can offer.

For now, BitFlow is focusing on selling the current solutions that are available, CXP-6. The Aon CXP is the younger brother of the very successful Cyton Family. The dual (Cyton CXP2) and quad (Cyton CXP4) link frame grabbers have been very instrumental in the multi link CXP cameras but the Aon has found a niche unto itself. A number of camera companies introduced the small footprint single link CXP camera at a direct competitor to the USB3 cameras. One of these cameras with an Aon CXP allows for greater flexibility, data rates, uninterrupted real time data acquisition and better ROI than experienced before in the machine vision world.

www.bitflow.com

Vision 2018 Hall 1, Booth 1A06

New NiR Polarizer

Effective, efficient, economical: The new MidOpt Pi1000 Series NiR Polarizer is effective in both visible and infrared ranges from 400-2000nm. It's efficient in glare reduction, with an average contrast ratio of up to 10,000:1 and has an operating temperature rating of 100° C per 1,000 hours. The Pi1000 is 40% less costly than current products on the market, making it highly economical. The new polarizer helps reduce glare in a variety of machine vision applications using infrared illumination. The Pi1000 is available as a film or laminated between glass with an oleophobic anti-reflection coating and can be custom-sized. It's offered unmounted for a light source or in a rotating mount with locking thumb screws for over a lens.

http://polarizer.midopt.com

Vision 2018 Hall 1, Booth 1G53

New Cost-effective CoaXPress Frame Grabber

Active Silicon has revealed their latest frame grabber – the FireBird Single CoaXPress Low Profile board. Maintaining all the industry-leading features of a high-performance FireBird board, this newest arrival has been optimized for cost so it has wider appeal for a greater range of applications. It is ideal for use with the latest range of small, lower-priced single-link CoaXPress cameras. CoaXPress in this combination offers a more affordable solution with all the advantages of higher bandwidths, real-time triggering, long cable lengths and the robustness and high reliability of a dedicated vision standard.

The low-profile design of this FireBird Single CoaXPress frame grabber allows the board to be used in small 2U enclosures; a full-height bracket is also available for standard PC cases. It is a 4-lane Gen2 PCI Express board and is fitted with a Micro-BNC connector, the latest standard for CoaXPress, which also supports PoCXP. Comprehensive I/O is provided, including front panel I/O.

www.activesilicon.com

Vision 2018 Hall 1, Booth 1H52

CoaXPress Frame Grabber Series

Silicon Software introduces two new members to its microEnable 5 marathon CXP family, the ACX-SP and ACX-DP. All compatible CoaXPress camera types can be connected to the image acquisition and processing boards. They are suited for all CoaXPress configurations (CXP-1to CXP-6) according to version 1.1.1.

The FPGA based microEnable 5 marathon frame grabber series has been developed for the Camera Link, Camera Link HS and CoaXPress cameras. Four CoaXPress boards are now part of the series: The A-Series, ACX-QP with four ports, ACX-DP with two ports and ACX-SP with one port as well as the programmable FPGA version VCX-QP (V-Series). The frame grabbers support color (RGB and Bayer) and monochrome area, line scan and CIS cameras across different topologies (single, dual and quad configurations) and up to 25 GB/s incoming bandwidth.

The new microEnable 5 marathon ACX-SP and ACX-DP frame grabbers consist of smaller versions with one or two camera ports for single link and dual link CXP cameras. They offer similar feature sets like the quad port frame grabber with an equally high bandwidth of 6.25 Gbit/s data rate per single CXP-6 connection. www.silicon-software.de

Vision 2018 Hall 1, Booth 1C72

For Higher Flexibility Regarding 3D Vision Applications

At Vision IDS Imaging Development Systems will introduce new models, functions and applications which demonstrate that the IDS NXT platform of vision app-based industrial cameras can change the image processing industry in a similar way. For example, the app-based approach allows recurring vision tasks to be set up and changed easily and in a very short time. With the ability to create any vision-based app, IDS NXT can be used in numerous applications and industries. For higher flexibility regarding 3D vision applications, the camera specialist will also present a prototype of the new Ensenso XR series with on-board processing: In contrast to the cameras of the N and X series, which use computers to calculate the 3D point clouds, this model can calculate them itself. Moreover, the 3D data can also be transferred directly to a control unit via GenICam in the future. Ensenso XR hence enables new scopes for application design, accurate acquisition of details and significant acceleration of data processing. Various demonstrations will emphasize what the different products in the camera manufacturer's portfolio are capable of. For example, IDS will show the new USB 3.1 Gen 1 board level cameras with liquid lens control. They facilitate image acquisition at variable object distances as their focus can be readjusted quickly and comfortably via user interface or API. The cameras are available with a 6.4 MP rolling shutter sensor from Sony or the highly photosensitive 18.1 MP rolling shutter sensor from ON Semiconductor.

www.ids-imaging.com

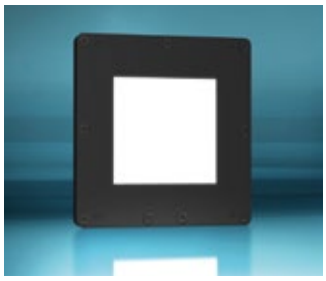
Vision 2018 Hall 1, Booth 1F72

LED-backlights with Integrated Flash Controller

The LED-backlights by Phlox are well-known for their homogeneous lighting and extraordinary luminosity. Now, the company offer a new line-up with integrated flash controllers. The lights are available with sizes ranging from 20x20 mm up to 500x500 mm in ultra compact IP65 cabinets with a thickness of only 14 mm. The lights are operated using a 24V power input, the puls width and intensity of the flash are set from 0V to 5V by adjusting two analog signals. To connect inputs, they use a 5-pin M12-connector.

www.phlox-gc.com

Vision 2018 Hall 1, Booth 1A72.5



Scientific Grade Peltier Cooled sCMOS Cameras

Increased challenges in Scientific field and industrial applications require further enhancement in camera quality and Ximea is preparing a combination of models based on the newest scientific

CMOS (sCMOS) sensors divided into versions with thermoelectric peltier cooling or PCI Express interface which delivers their full-speed potential.

The whole range of cameras is equipped with sCMOS sensors handpicked from the extraordinary line introduced by Gpixel, concentrating on excellent low noise values and high dynamic range. www.ximea.com

Vision 2018 Hall 1, Booth 1C51

A Broad Concept

The Goals of Embedded Machine Vision and Their Realization

The principles of embedded technology lead to a very broad range of possible solutions for embedded machine vision systems. With the right components, building such a system is facilitated and pay-off becomes predictable.

The term embedded implies an independently working but integral part of a system with no extra device or add-on. Consequently, embedded vision systems adjust to the requirements of the relevant machine which affects both the form factor and the integration of communication interfaces as well as camera and computer requirements. Of course, the application software is also specifically written and optimized for the same machine.

A Broad Range of Solutions

If you look at it like this, the range of possible solutions is very broad, as the following two examples show:

1) A stereo sensor board is integrated into the gripping device of a robot as a circuit board. The system operates with the robot via fieldbus protocol, camera resolution and distance are designed in an application-optimized way, and the circuit board is developed as compact as possible to be mounted into the device.

2) A camera traverse is integrated into a machine that handles sheet material. It is composed of a crossbar with intelligent line scan cameras, line lighting, and lenses designed for the working distance and the field of view. An incremental encoder, positioned at the product, enables the synchronization with varying machine speeds or changes of direction. Every line scan camera independently inspects a designated part of the sheet material and reports defects to a supervisory panel PC. The machine's electrical cabinet is omitted due to space constraints. The line scan camera´s program is designed for the quality inspection of the web or sheet material, including the optimization of algorithms to meet the requirements of fast machines.

Both cases show in a simplified way that embedded machine vision must meet various demands in contrast to commercial applications, where a simple camera with a small ARM processor is often a sufficient solution.

A Variety of Improvements

Apart from completely new ideas, decision makers of image processing systems often ask themselves whether an existing application will be realized as an embedded machine vision solution in the next generation. Actually, quite a few past obstacles no longer exist, so there are various improvements:

> *“A few past obstacles no longer exist, so embedded machine vision solutions have become future-proof.”*

- Windows-based application programs can be ported to Linux operating systems much more easily than before. If you are using the Halcon library, it runs on different processors and operating systems. With a few tips and tricks derived from recent portings, it is easy to overcome the few obstacles.
- HMI/GUI: The operation of established programs on the local Windows PC has become outdated. Just think of brows-

Real-time I/O meets ARM-based computing power with the VisionBox Le Mans

The VisionCam LM enables embedded machine vision for line scanning.

er-based, decentralized operation. This is why the Human Machine Interface (HMI) – regardless of the platform – has to be redesigned according to new requirements.

- Computing power: Very compact, intelligent cameras like Imago's VisionCam now include multicore ARM processors with a computing power only large IPCs were known for just a few years ago.
- Young generation: What is the expertise of today's well-educated young engineers and computer scientists? Linux, of course. They often have first experiences with embedded boards. But of course, experienced developers, too, have been realizing the chances and benefits of their computer architecture knowledge for a long time.
- Middleware: The software and firmware that provide application developers with convenience, i.e. software development kits (SDKs) for several interfaces, already incorporated libraries, sample programs, integrated image processing libraries. Their high standard allows a quick start and reduces development times.

Quick Start

In order to get started, Imago offers a complete portfolio of embedded machine vision components designed for the broad range of embedded machine vision solutions. It includes the VisionBox Le Mans for processing computing-intensive applications in real time with an 8-core ARM Cortex-A72 and offers machine and camera interfaces. With a 2-core ARM Cortex-A15 as well as an OpenCL manageable dual-core accelerator, the CPU is integrated in the VisionCam. Gigabit-Ethernet, fieldbus, I/O, encoder interface – everything is prepared for processing the image data from area or line scan sensors that offer a resolution of up to 5 MPixels or 8k. For an easy start the VisionSensor PV offers the possibility of solving sensor tasks simply via the vision system.

Pay-off Time

When does embedded vision pay off financially? The total prices of today's series systems – added up over a lifecycle of several years – must be compared to the price of a single embedded machine vision system and its one-time development costs. Imago realizes original design manufacturer (ODM) customizations starting from just 25 units per year if the product is planned to be available in the market for several years.

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Vision 2018 Hall 1, Booth 1F21

Scalable Solutions for Realizing an AI Vision

Hardware and Software Solutions to Make AI Vision Systems a Reality

Machine vision has become a major aspect of productivity in the Industrial IoT, and by putting AI into vision systems, processes can execute faster with more accuracy.

Anyone active in any technology sector cannot fail to have noticed that Artificial Intelligence is experiencing a renaissance. Although it has been around for many years and used extensively in specific application areas, AI is only now becoming what analysts might call a disruptive technology. The reasons for that are manifold; in part it is because the applications for AI are expanding as more people appreciate how it can be useful, but perhaps more significantly it is because the platforms for AI are more numerous, more powerful and more deployable.

The Evolution of AI

Some of the most notable limiting factors with yesterday's AI were that its efficacy was directly related to the available processing performance, and that every instance of AI needed to be very carefully and painstakingly trained for one particular application. While this wasn't a major barrier to its adoption, it was enough to keep the mainstream at arm's length. Today, Moore's Law means the processing performance needed is much more accessible, but perhaps more importantly, the entire AI industry has evolved to what we now call inference engines. The belief is that AI inference will become dominant and take will take Deep Learning to a new level. Training will always be required but inference, based on training, will become magnitudes greater.

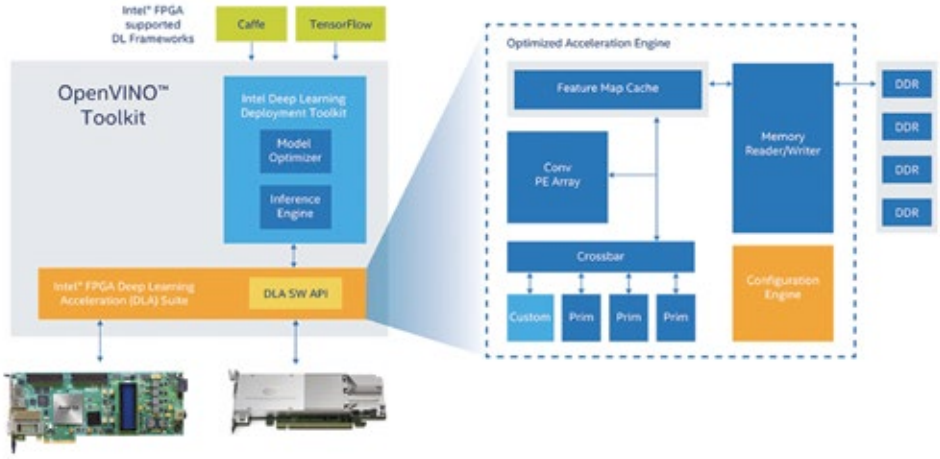
What is also apparent is that high performance AI algorithms are no longer expected to just run in large mainframe computers. Today, that may translate to Cloud Computing and that is an important aspect of AI, but it is only part of the picture. The reality is that in order to really benefit from the full potential of AI it needs to be everywhere, from the cloud to the edge. Putting inference at the edge represents a new paradigm in the IoT and it is starting with vision.

The Data Paradigm

Vision systems have become a yardstick for technological innovation. We now use machine vision in production and manufacturing; it has become a crucially important aspect of productivity in today's Industrial IoT, and by putting AI into vision systems, processes can execute faster with more accuracy. Intelligent surveillance is another area where visions systems are evolving rapidly, using algorithms to not only recognize people, places and objects, but to quantify those things in real-time from hundreds of sources.

The big data paradigm is here and AI is really the only way it can be handled, not simply in the cloud and large data centers, but right where it's being generated; at the edge. Intel is instrumental in this evolution of AI, by providing the tools and technologies, the hardware and software, to make developing and deploying AI-based vision systems fast, reliable and efficient. This takes a strategy that understands the diverse way in which AI is being deployed, and then building a portfolio of solutions that enables developers to move from model to real-world deployment.

Realizing an "AI everywhere" philosophy takes a multi-architecture approach. The vast array of the company´s vision products extends from hardware platforms that are optimized for handling massive and unstructured data sets all the way to extremely low-power silicon that can deliver on-device inference. This could take the form of a single Intel FPGA providing the sensor interface, image processing and video output for a machine vision system, to the AI processors powering the workstations that are used to develop the AI models that add even greater value. This milli-watt to multi-watt portfolio



The key parts of the Intel OpenVINO toolkit

not only provides the right device at every point in the AI architecture, but also extends beyond the processor to include storage, memory and communication solutions, from general purpose to application-specific, power-constrained to data powerhouse.

Software Speeds Deployment

A total solution approach requires an extensive hardware portfolio complemented by the software needed to fully leverage the performance available.

For example, the Open Visual Inference and Neural Network Optimization (OpenVINO) toolkit, complemented by the Intel FPGA Deep Learning Acceleration (DLA) Suite, enables the development of deployable systems that closely emulate the way human vision works. It uses Convolutional Neural Networks to enable deep learning inference where it can be most impactful; at the edge. As a multi-architecture solution, it can operate across a heterogeneous platform, including CPUs, CPU with integrated graphics, Vision Processing Units (VPUs) and FPGAs thanks to its common API. Supported by a library of functions, it is also optimized to work alongside OpenCV and OpenVX.

The Deep Learning Deployment Toolkit enables cross-platform development and is packaged with the FPGA DLA Suite. It gives researchers and developers access to the software graph compiler, libraries and runtimes needed to deploy AI inference in a way that is optimized for price, performance and power using the company's own FPGAs.

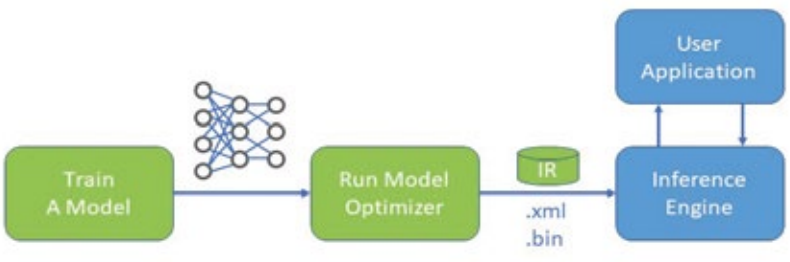
The resurgence in AI is in large part due to its adoption by power users like social media platforms, but momentum is building. Large, small and medium sized enterprises are now looking at how they can leverage AI, using a combination of talented people and technology, to turn the hype into a reality. It starts with rough, raw data and culminates in business intelligence, in a way that works for the user. By providing scalable solutions and a mixture of standard and custom tools and platforms, Intel is breaking down the barriers to AI. It extends from the edge all the way to the cloud, and the company offers a solution at every point. This includes architecting servers built for AI, using breakthroughs such as Intel Rack Scale Design, which offers on-demand compute, storage and connectivity using innovations like photonic networks that can move data at the speed of light.

The Internet of Things will see billions of cameras coming online; combining vision systems with machine learning will create new use-cases that will change the way we design and build products, deliver services and secure our homes, work places and lives in general. Before the end of this decade almost half of all video data generated will be analyzed at the edge of the network, to provide actionable results. This will change the way AI models are generated and deployed, and with advanced technologies developers have access to the hardware and software solutions they need to make their AI vision system a reality.

> *"Large, small and medium sized enterprises are now looking at how they can leverage AI, using a combination of talented people and technology, to turn the hype into a reality."*

Author

Tony Kau, Software and AI Marketing Director



The key steps for optimizing and deploying a trained model

Contact

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Vision 2018 Hall 1, Booth 1C42

Santa Clara Convention Center

Edge or Cloud: It's All Embedded

From May 21 to 24, the Santa Clara Convention Center again hosted the annual Embedded Vision Summit, gathering over 1,000 computer vision experts, users and investors from all the world. inspect met Jeff Bier, founder of the Embedded Vision Alliance and organizer of this particular event.

inspect: Jeff, what was your overall impression of this year's Embedded Vision Summit? Compared with past Summits, what was new, what was different?

Jeff Bier: From the presentations, exhibits, and attendees at this year's Embedded Vision Summit, it's clear that we've crossed a critical threshold, such that it is now feasible to deploy vision in many applications that were previously not possible. It's exciting to see the creativity of engineers and business people who are applying this technology to solve important problems, from monitoring the health of elderly people to optimizing the production of large greenhouses.

inspect: Which major trends have you identified that will drive and accelerate the deployment of embedded vision systems in the near future?

Jeff Bier: At this year's Embedded Vision Summit, I observed four interesting trends:

- Of course, algorithms are central to computer vision – algorithms are what transforms pixels into actionable information. Lately, algorithms have been improving rapidly, thanks to deep learning, and this is enabling many new vision applications.
- Whether based on deep learning or other techniques, vision algorithms are very computationally demanding. For many applications, it's critical to have processors that can deliver enormous processing performance at low cost and power consumption. Here again, the rate of improvement has accelerated dramatically.
- Similarly, now that 3D imaging sensors are being adopted in high-volume applications like mobile phones, the cost, size and power consumption of these sensors are all dropping fast. This means that many applications can now incorporate 3D vision.
- Cloud computing is playing a growing role in vision. Even for edge devices, in many case developers have the option of doing some or all of their vision processing in the cloud. This can significantly simplify product development for some types of applications.

inspect: Deep learning seems to rock the arena. In which fields of application is it already commonly used today, and which applications do you expect to come next?

Jeff Bier: Deep learning is being used to some extent in most vision application domains today. According to the Embedded Vision Alliance's Computer Vision Developer Survey, developers in security/surveillance and automotive markets are most likely to be using deep learning. More mature industries such as medical and industrial equipment are less likely to be using deep learning – but even in these segments, we find over one third of developers are using deep learning.

inspect: During the Summit, Intel's new 3D camera was awarded Best Camera of the Year. Why is 3D vision becoming such an important factor in vision systems?

Jeff Bier: We live in a three-dimensional world, and for many applications, such as mobile and stationary robots, understanding the world in three dimensions is critical. We can often infer 3D information

Jeff Bier

from 2D sensors, but having 3D sensors can significantly simplify things.

inspect: Deep learning and 3D vision, among others, require a lot of computational power. What progress can we expect from processors, algorithms, frameworks etc.?
Jeff Bier: In many technology domains, we are accustomed to a slow, steady progress which, over a period of years, yields big improvements. But in some fields, at some points in time, technology advances very quickly. We're now experiencing a period of very rapid improvement in processors, sensors, algorithms and development tools for computer vision applications. For example, I estimate that we will see improvements of over 1,000x in performance/cost and performance/power for deployment of deep learning inference within just two or three years, thanks to improvements in algorithms, software tools and processors. This kind of rapid improvement really changes the game in terms of what can be done practically and economically.

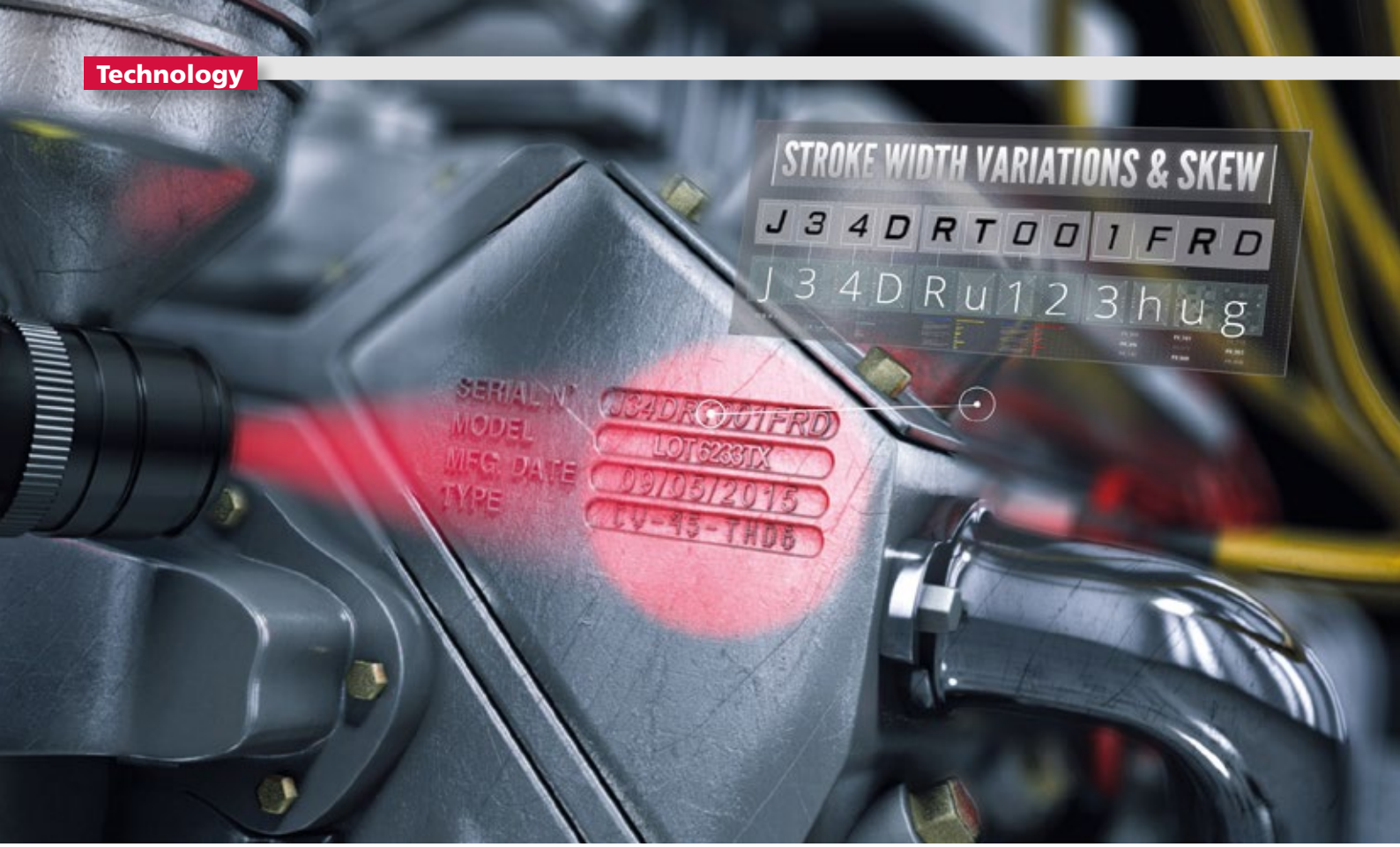
inspect: We have learned that embedded vision does not necessarily mean edge computing but may also include cloud-based solutions. What benefits does the cloud offer compared to the edge, and vice-versa?
Jeff Bier: Edge and cloud computing both have significant advantages. Cloud computing offers great resources to help developers quickly and economically create, test, deploy and scale applications. In other words, it's easier to create solutions using the cloud. On the other hand, edge processing can achieve fastest response times, better privacy, and no recurring costs for data transmission and computation.

inspect: The Embedded Vision Alliance was founded in 2011. How many member companies have been included by now and what type of companies are these? What services do you offer for your members and how can the Alliance help to support their business development?
Jeff Bier: The Embedded Vision Alliance now comprises 85 member companies. For most of our seven-year history, we have focused our membership benefits on companies that provide building-block technologies, such as processors, algorithms and camera modules. The Alliance helps these companies connect with new customers and partners, and to get early insights into key technology and market trends. More recently, the Alliance has established a new membership class for companies designing systems and solutions. The Alliance helps these companies accelerate the incorporation of vision into their products, for example by providing training for technical and business people, and by helping them find the best technologies and suppliers to meet their needs.

Presentations and slides of the Embedded Vision Summit 2018 can be downloaded from the Embedded Vision Alliance's website (see link below). The next Embedded Vision Summit will take place from May 20 to 23, 2019, again in Santa Clara.

Contact

Embedded Vision Alliance, Walnut Creek, CA, USA
www.embedded-vision.com/2018-summit-talks



Deep Learning

Self-Learning, Powerful and Almost Human Image Analyses

Artificial intelligence (AI) and deep learning open up a new range of applications for vision technology. With a new deep learning-based machine vision complex challenges can now be reliably solved.

The complexity of a difficult application is no longer an insurmountable problem: With the direct integration of a new, deep learning-based machine vision software for automatic identification, inspection and classification, complicated applications can be solved simply and quickly, even without relevant AI expertise.

Cognex VisionPro ViDi is the first deep learning-based image analysis software designed specifically for factory automation. It offers a field-tested, optimised and reliable software solution using the most modern algorithms for machine learning. The software combines artificial intelligence (AI) with robust machine vision packages such as Cognex Designer Software. It is thus able to solve complex applications that would be too difficult, time-consuming and expensive for traditional machine vision systems. Cognex VisionPro ViDi uses four powerful tool sets:

- ViDi Blue Locate finds and identifies features;
- ViDi Red Analyze segments and detects anomalies;
- ViDi Green Classify classifies objects and scenes;
- ViDi Blue Read deciphers text and characters

New deep learning technology functions reliably even when anomalies and unpredictable defects occur, and it is able to outperform even the best quality inspectors. It is used primarily to locate and identify deformed features; to separate anomalies and identify defects; to classify texture and material and to perform demanding OCR applications (even where the printing is distorted).

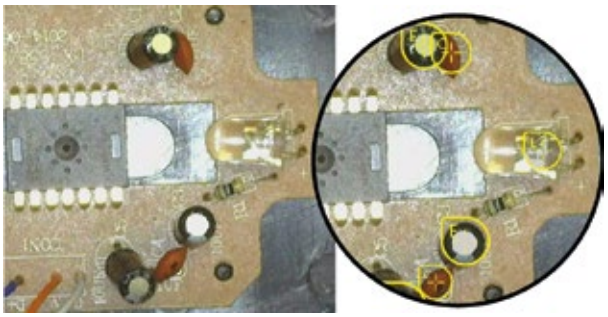
Location and Identification of Deformed Features

ViDi Blue Locate finds complex features and objects by learning from annotated images. Self-learning algorithms locate parts, count translucent glass medical on a tray and perform quality control checks on kits and packages. To train the tool, all the operator needs to provide are images on which the relevant features are marked.

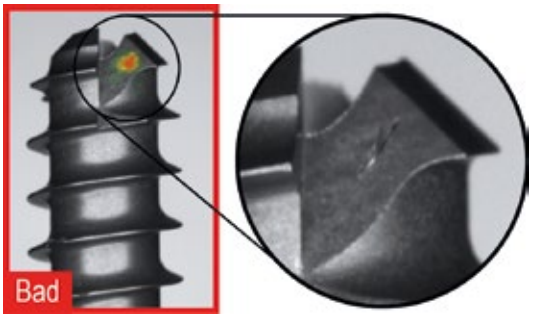
For certain identification, counting and classification applications, manufacturers must rely upon visual inspection when their environments do not support bar code reading technology. However, slight variations in appearance can cause problems for machine vision inspection systems. This is the case with spark plugs, which arrive for pre-assembly on differently coloured trays. ViDi Blue Locate and Green Classify identify, count and classify the spark plugs based on their appearance ready for packaging and pre-assembly inspection.

Defect Detection and Segmentation

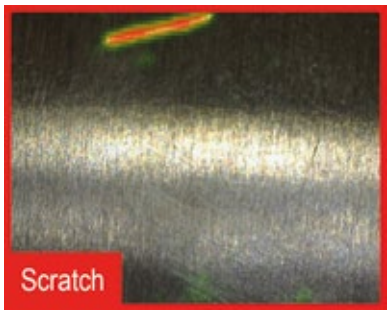
ViDi Red Analyze is used to identify anomalies and aesthetic defects, be they scratches on an embellished surface, incomplete or improper assemblies and even weaving



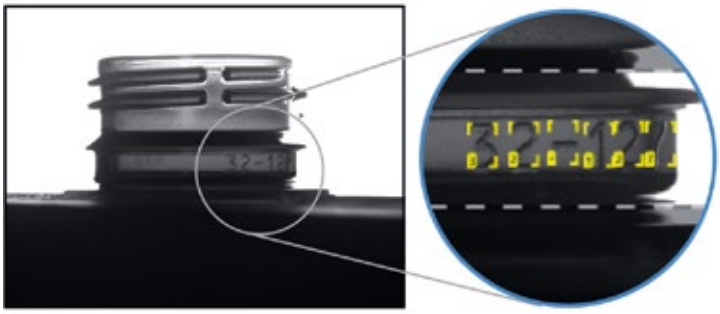
ViDi Blue Locate finds and identifies features.



ViDi Red Analyze segments and detects anomalies.



ViDi Green Classify classifies objects and scenes.



ViDi Blue Read deciphers text and characters.

problems in textiles. This tool set can identify all these problems very simply by learning the normal appearance of an object, including any significant but permissible variations.

The analyses tool is also used to segment areas of special interest such – as the presence of foreign material on a medical fabric. The Analyse tool can reliably identify the relevant area simply by learning the varying appearance of the targeted zone.

The analyses tool simplifies the automatic detection and classification of defects on textured metal surfaces, as in the inspection of piston rings. During cylinder inspection, the tool also reliably detects pores in the metal. The tool is also used in the inspection of textiles, including airbags. Airbags are subject to strict quality standards to ensure passenger safety. Automotive manufacturers must double and triple check all safety-critical components to ensure quality and reduce warranty and re-call costs.

Classification of Objects and Scenes

ViDi Green-Classify is used to classify an individual object or a complete scene, be it the identification of products based on their packaging, the classification of weld seam quality or the separation of acceptable from unacceptable anomalies. The tool learns to distinguish between various classes based on a collection of images. All that is required for the learning-in process are images assigned to and labelled in accordance with the various classes.

> *“The software solution with algorithms for machine learning combines artificial intelligence with the robustness of machine vision to solve complex applications that would be too difficult, time-consuming and expensive for traditional image processing systems.”*

Piston weld seams are highly variable, making anomalies difficult to identify. Certain anomalies, such as missing, overpowered or underpowered weld seams, are undesirable. However, other anomalies, including overlapping seams, are desirable and even essential for safety reasons. The ViDi Red Analyze tool, in combination with ViDi Green Classify, simplifies the automatic inspection and classification of weld seam defects.

Reading Text and Characters

ViDi Blue Read deciphers badly deformed, skewed and poorly etched characters using optical character recognition, OCR. The pre-trained font library identifies most text without additional programming or font training, delivering a quick and easy application. This robust tool can be trained to adjust to specific OCR application requirements. No special expertise is required for this.

Automotive manufacturers must be able to locate and decode chassis or vehicle identification numbers (VIN) for successful traceability. Paint colours, specular effects and glare make it difficult for traditional machine vision systems to locate and recognize characters. The reading tool, however, reliably identifies all deformed characters during the VIN inspection.

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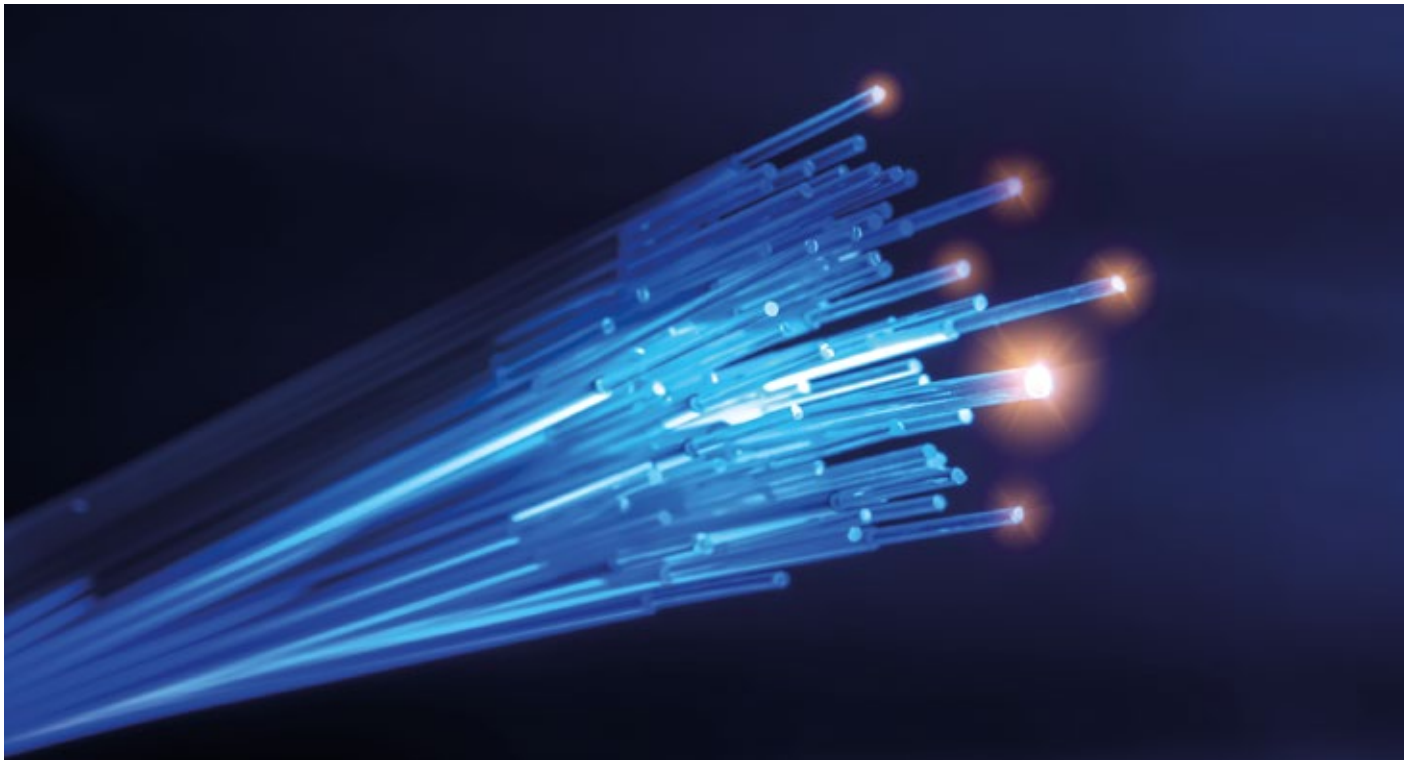
Vision 2018 Hall 1, Booth 1D72



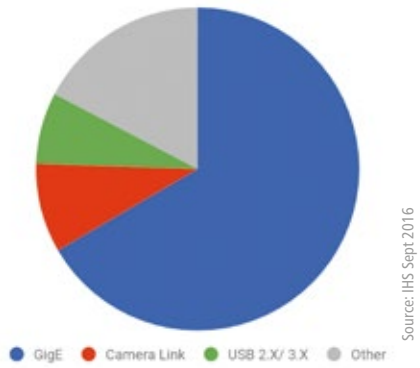
The Next Generation

Transmission Standards in Industrial Image Processing

What are the key transmission standards used in machine vision and what trade-offs should be balanced when selecting one?

Machine vision has significantly improved the speed, the quality and the cost of manufacturing and production for countless sectors of goods. The technology has allowed near-perfect error detection, the ability to track items throughout a system and picking/ placing to an exceptional accuracy; and this has made a huge difference to industries as diverse as manufacturing, pharmaceuticals, agriculture, ITS and electronic board assembly. And this is not just for a subset of processes, but for a near unending set – from car inspection systems that drive down recalls to food sorting and even luxury-watch manufacturing, where previously only the reliance on master craftsmen was trusted.

With technological advances, systems have been able to look beyond accuracy to address cost and speed – not only avoiding either false positives or negatives but doing so more affordably and without stopping (or even slowing in most cases) the production line.



Source: IHS Sept 2016

The major major machine vision standards – GigE, USB and Camera Link – are forecast to account for 83% (currently 82%) of the Machine Vision market by revenue. Other includes all standards with a smaller than 2% market share.

Holistic Design

From the sensor itself, to how the camera module is optimised to get the most from the sensor, to the pre-/post-processing features, to how the lighting is controlled, and how many cameras are required to capture multiple angles/light frequencies – the design of the right machine vision system/module is about more than the sensor itself.

In short, a holistic design approach that delivers the most from the sensor is essential – something that has traditionally been a differentiator for Sony's camera modules. And a key element of this design is how you stream data from the camera, so that data isn't lost or slowed.

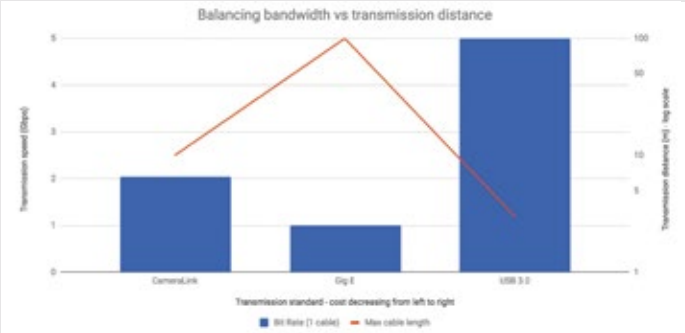
The Key Standards

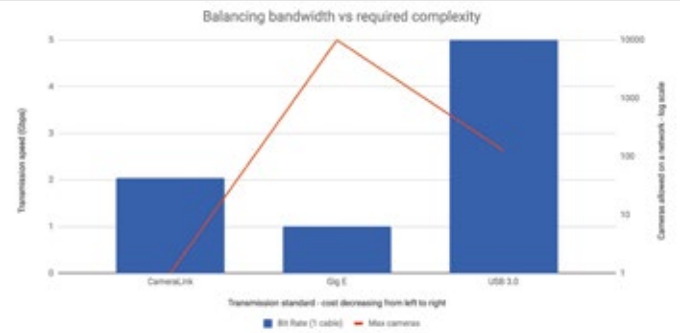
In the EMEA region, despite the development of new technologies, forecasts for 2021 suggest today's current three dominant standards – GigE Vision, Camera Link and USB Vision (combined 2.X and 3.X) – will continue to dominate, with these used in systems that make up 83 % of the hardware market by revenue. This is broken down further below, showing the 12 most-commonly-used standards, including a breakdown for USB 2.X/ 3.X.

Balancing the Trade-offs

Arguably one of, if not the most significant trade-off to be made in any project is bandwidth versus distance. Closely followed by cost and complexity. The graphs on page 51 show how the three major transmission standards balance this:

A greater bandwidth allows a greater number of features to be included in the camera. If we take a look at the Sony XCL-SG510, for example, this uses the





The trade-offs of bandwidth, transmission distance and complexity for the three major standards. Standards are ordered by cost, reducing from left to right.

Camera Link standard's bandwidth to send 5.1-megapixel images at 54fps but also uses it to enable more advanced (yet bandwidth-intensive) features such wide dynamic range, where multiple images are captured at varying exposure levels and a composite image created to bring out extra detail. As per the above graphs, the switch to USB increases the available bandwidth significantly.

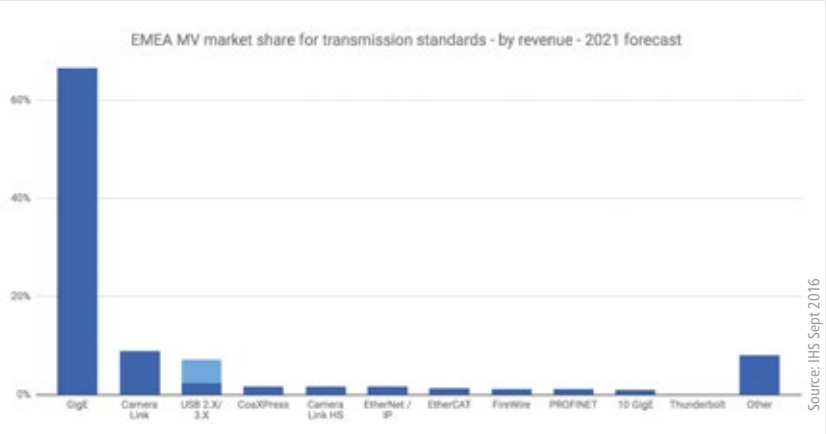
This is, of course, not the complete picture. As mentioned, other trade-offs that need to be factored into a design include cost, the number of cameras that need to be placed on a network and some standards also give the ability to improve transmission speeds by additional cables – the CoaXPress CXP-6 Quad standard, for example, allows four cables to be used to deliver 25 Gbps (4 * 6.25 Gbps); this ability to increase speed with multiple cables is also true of Camera Link, but the total speed depends on the configuration setup (base, medium, full, extended full) and it is not a simple doubling.

> *"The design of the right machine vision system/ module is about more than the sensor itself."*

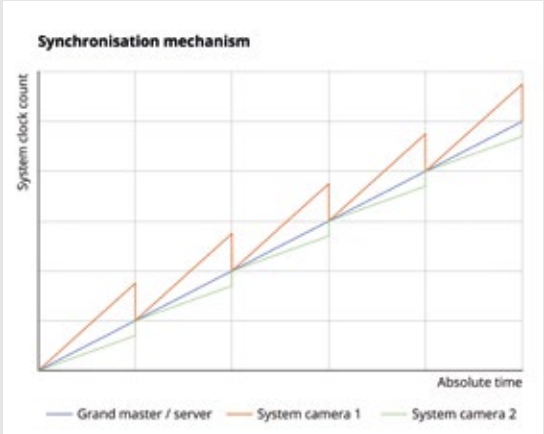
And on top of this is GigE's ability to use IEEE1588 to reduce overall system cost in synchronous multi-camera systems by eliminating the need for additional hardware – such as a GPS timing chip.

Next Generation Standards

The choice of transmission standard also needs to work with existing infrastructure



After GigE, Camera Link and USB, the next eight most-used standards account for less than 10% of the overall by revenue. USB 3.X's relative market share is shown in light blue.



Resynchronising a fast and slow camera to the master using the precision time protocol

and this varies significantly by region. In the Far East, Camera Link is very commonly used; whereas in Europe GigE has over 50 % market share. Will people switch? Yes, conversations with customers suggest a pragmatic approach to design and where the application allows, customers would support, for example, a switch to Camera Link from GigE due to the superior frame rate it supports.

On top of this is the rise of next generation transmission standards – such as 10 GigE and Camera Link HS. These both allow transmission speeds up to 10 Gbps (depending on configuration) over longer distances – in the case of 10 GigE, up to 100 m.

It should however be noted that not all of these new standards are backwards compatible. 10 GigE can be integrated seamlessly with existing infrastructure. However, Camera Link HS is not simply an evolution of the 2.0 standard and we'll have to see if this affects its uptake.

Making the System Work Cohesively

For a vast (and still growing) number of applications, there is a need for multiple cameras to work together to collect more information.

A good example comes from agriculture, where inspection takes place while fruit or vegetables come down a conveyor – often covered in dirt. Images from multiple cameras are used to interpret exactly which meet supermarket standards, which are acceptable albeit imperfect, which can go to juice, and which are damaged, infected or mouldy.

To manage this, with few false positives and even fewer false negatives, it needs multiple cameras – with colour, near-infrared and even polarised and/or hyperspectral sensors – to distinguish between a normal mark, a bruise, an infection and even a hidden object under the skin. The ability for cameras to fire at precisely the same time and capture exactly the same image is therefore vital.

> *"The ability for cameras to fire at precisely the same time and capture exactly the same image is vital."*

In a standard camera, clock speeds are arbitrary and unique, and there is no link between devices. This means you cannot simply programme a different module to fire at the same, precise time. The way this has traditionally been managed is to use hardware triggering, via a GPS chip. This gives the accuracy – GPS is accurate to the nanosecond – but also adds significant cost and creates a single point of failure in the system. The precision timing protocol IEEE1588 can be implemented as an alternative with the GigE v2.0 communication standard. This dynamically assigns a master clock (allowing for component failure) and, at regular intervals, synchronises all components in the system to the same clock. Using this protocol, it is possible to get the precision to microsecond accuracy – enough for virtually all machine vision applications.

Furthermore, the protocol can be used to link not just cameras, but the rest of the system – from the robot to the lens to the lighting. Individual components can exchange parameters via Ethernet and be triggered over Ethernet, which means it's possible to accurately synchronise, for example, the light pulses and the camera ring and adjust quickly on the fly.

In machine vision systems, cameras were traditionally capable of acting solely as the IEEE1588 slave device, with a dedicated item of hardware needed as master. This again added cost, especially when you add in a backup in case of failure.

This changed in late 2016, when Sony launched the first machine vision camera capable of being the master. 2017's Sony XCG-CG510 and XCG-CG240 extend this concept, combining an acquisition scheduler, software-trigger, GPO-control and user-set load action command types. This enables Sony's GS CMOS machine vision cameras to realise the industry's most precise pre-scheduled image acquisition synchronisation in real-world environments.

The Holistic Approach Makes the Difference

Machine vision has played a huge role in improving manufacturing – not just in terms of quality, but speed and error detection. A holistic approach to camera module design is critical to this, with the module optimised for the sensor. Similarly, the transmission standard is about more than just bandwidth and should be chosen for the features it enables – be it the synchronisation of lighting, robotics and camera triggering, or for the bandwidth to allow wide dynamic range.

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Vision 2018 Hall 1, Booth 1C37

Better Image Quality at a Lower Price

Flir Systems announced the launch of the Flir One Pro LT, a new lower price point thermal imaging attachment for smartphones in the Flir One Pro series. It features many of the professional-level tools and advanced thermal image quality that define the series.

Powered by the Flir Lepton thermal micro-camera core, the Flir One Pro LT builds on the advanced features of the Flir One Pro. Key tools include Flir's patented MSX image enhancement, which combines the thermal and a high-definition visible camera images to produce crisp, detailed images that are easy to interpret. All models feature Flir's MSX and VividIR video signal processing technology to deliver improved thermal image quality and clarity. Additionally, the patent-pending OneFit camera connector allows users to adjust the device to attach to their smartphone through many popular protective cases. Flir is also releasing an updated version of the Flir One App. www.flir.com

Vision 2018 Hall 1, Booth 1B42

Go Anywhere, Inspect Anywhere

Designed to be taken anywhere, Olympus' durable, lightweight IPLEX G Lite videoscope helps inspectors see clearly during challenging inspections, such as inside engines and pipes. With bright, powerful illumination and easy articulation, the IPLEX G Lite produces sharp images and videos for confidence in inspections and reliable reporting.

Well suited to the often-adverse conditions of industrial inspections, the durable, rugged design of the newly launched videoscope thrives where others fail. It carries an IP65 rating and is resistant to rain, high humidity, salt fog, dust, freezing rain, and even electromagnetic or explosive environments. The IPLEX G Lite is also extremely lightweight (1.15 kg) and can be easily carried and operated with one hand.

Despite its compact size, the IPLEX G Lite does not compromise on illumination. Its bright LED light source has twice the light intensity of its predecessor so that large, dark spaces can be inspected with bright, detailed images. Furthermore, the PulsarPic image processor automatically optimises lighting conditions, while wider image processing maximises contrast in dark areas for increased probability of detection. www.olympus-ims.com

Miniature Monoscope with FIR-VIS Fusion

"We are proud to present the new X-SEE FusIR monoscope, which uses the most advanced technologies to offer outstanding image fusion performance in miniature monoscopes," said Jacob Dagan, President & CEO of Senso-Optics. "The new X-SEE FusIR monoscope is based on our proprietary Camera-on-Chip (ASIC) image processor, which generates exceptional image quality with VGA resolution (640x480) within tiny dimensions, weight & power consumption (SWaP). It offers the advantages of both VIS & FIR spectrum channels, day and night and in all-weather and environmental conditions (fog, dust, smoke, haze etc.). With X-SEE FusIR's blended fused image, users can now see through glass windows, lights, signs and even colors, which they cannot do with thermal imaging alone."

The X-SEE monoscope weighs only 300g with X1 lens, 400g with X2 lens and 700g with X4 lens, to suit a range of user requirements. It features several fusion modalities, including FIR (thermal-imaging) only, VIS (visual) only, controllable FIR-VIS blending, and other features.

www.senso-optics.com

Unique Insight into Nano Events

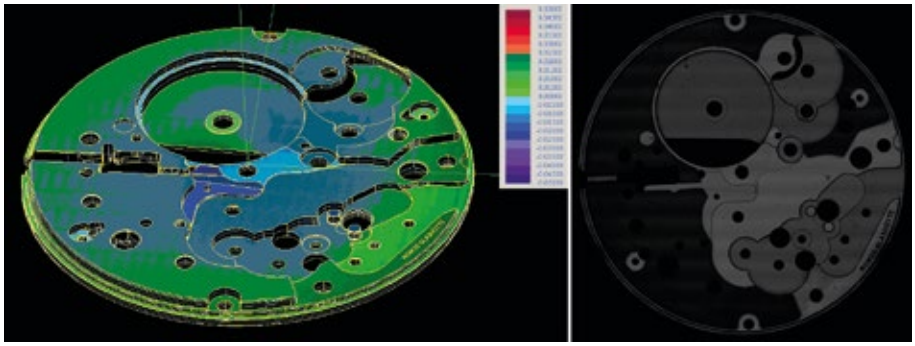
Specialised Imaging has enabled researchers to couple a streak camera directly into the same optical path used in their SIM ultra-fast framing cameras. This innovation allows capture of framing and streak data on the same event using the same optical path for direct correlation of 2D and streak image data. The combination streak/framing camera has allowed researchers to attain performance levels never before achieved using dual camera systems with different optical inputs.

Benefiting from using a common optical input and dedicated output window the Specialised Imaging Simultaneous Multichannel Framing Camera and Streak Camera system drastically simplifies optical set up and eliminates perspective distortion (parallax errors). Beneficially the set-up also allows use of an existing streak camera which can still be used independently.

Capable of capturing data at 1 billion frames per second, the SIM range of

ultra-fast framing cameras offer the ultimate in ultra-high-speed imaging performance to scientists and engineers across all disciplines. The proprietary optical design of SIM cameras offers up to 32 images without compromising shading, or parallax.

www.specialised-imaging.com



Rapid Measurement of Various Surfaces

Werth Messtechnik presents the latest innovation in its extensive selection of sensors: with the Chromatic Focus Line (CFL) sensor, entire workpiece geometries are captured rapidly. Using different lenses, the measurement uncertainty and range can be adapted to a particular application. Due to the large axial measurement range, exact tracking of the workpiece geometry is unnecessary, so large areas can be rapidly and easily captured by scanning. Workpieces with large variations in height may be scanned along a pre-defined 3D path. The Chromatic Focus Line sensor measures workpieces with diffuse, reflective, and transparent surfaces, as well as surfaces with large inclination.

The CFL projects a series of about 200 white light points onto the surface of the workpiece. The light reflected from the surface is spectrally analyzed to determine the distance between the sensor and the surface. This new linear sensor is the first to be able to perform a complete 3D capture of the workpiece with both high accuracy and high speed. It measures about one million measurement points in three seconds.

The Chromatic Focus Line sensor provides another interesting function: in addition to the wavelength of the reflected light, its intensity is also analyzed and a raster image of the workpiece surface is generated. Subsequent analysis with image processing software allows measurement "in the image" of geometric features or definition of the workpiece coordinate system. The positions for measurements with a variety of other sensors are determined on this basis, without requiring a sensor change.

www.werth.de

Automated Centering of Lens Systems

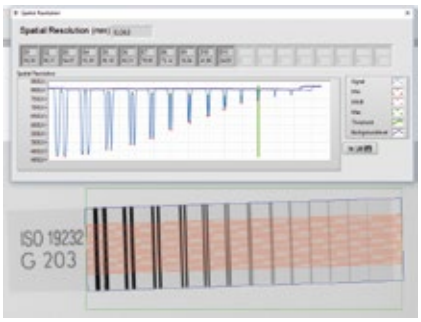
Trioptics presented robot-based automation solutions for loading the OptiCentric 100 centration inspection system and the ATS 100 alignment turning station for volume production.

For many years, Trioptics has supplied automated systems to increase the efficiency of optics production. This is especially true for all solutions used to center and inspect lens systems. Dr. Patrik Langehanenberg, product manager for the OptiCentric centration inspection systems, explains: "There are a number of reasons for our focus on automation. One reason is that it increases the process reliability of our systems. Unfortunately, in many processes, operators are the limiting factor for accuracy and process time. Here, robotic processes allow improvements." As a result, many processes in the OptiCentric systems and in the ATS alignment turning station have been automated for years. Now Trioptics is taking automation to the next level. "In volume production, operators used to insert the lenses manually and then start the process," reports Dr. Christian Buß, product manager for ATS. "Now we use robots that do the loading and unloading process in one operation while the operator does other jobs or loads lens trays into other systems."

www.trioptics.com

600kV High-energy X-ray System

Designed to allow a flexible inspection process, nine independently CNC controlled axes let the XRHGantry fulfill even the most advanced requirements. This XRHGantry version is designed for the inspection of high energy applications for thick and heavy parts. Typical use cases are within the aerospace and defense sector. The system is equipped with a 600kV X-ray source and can also be upgraded to linear accelerators or Betatrons. The automated cart can bring parts into the system on rails.



Designed to allow a flexible inspection process nine independently CNC controlled axes let the XRHGantry fulfill even the most advanced requirements. Additionally, the system is equipped with a 16-inch digital detector, a tube sided shielding bar and an ultra-precise diaphragm. The high precisions of the turntables allow even Computed Tomography (CT) scans of the objects. The system was especially designed for tangential real-time inspection of solid-state rocket motors. Nevertheless, the system can be adapted to many applications.

www.visiconsult.de

Prism-based line scan camera SW-4000T-10GE

Split the Light

Prism-based Line Scan Technology

In a new approach, prism-based line scan technology in cameras is combined with a 10GBASE-T interface with backwards compatibility to NBASE-T and 1000BASE-T speeds.

Color line scan technology consists of two main categories: a multi-line approach and a prism-based approach. A multi-line approach could be a dual-line Bayer pattern approach, trilinear R-G-B, a quad-line R-G-B-NIR multi-line sensor with multi-spectral filters, or a time delay and integration (TDI) approach. A prism-based approach uses a prism to split the light entering a camera system; the light filtered onto the prism block is directed towards sensors which are uniquely placed to capture every light separation. This article explains a new approach in line scan cameras where an R-G-B prism-based approach is combined with a 10GBASE-T interface that has backwards compatibility to NBASE-T and 1000BASE-T.

For the Slowest and the Fastest

The combination of prism line scan with the 10GBASE-T interface not only makes JAI´s camera SW-4000T-10GE the world´s first product of its kind but also the world´s fastest prism-based line scan camera. At a resolution of 4,096 pixels per channel and speeds above 100 kHz (100,000 lines/second), this camera is designed to cover the slowest and the fastest line scan applications. Furthermore, this camera is based on an innovative multi-line sensor technology which allows a user-selectable pixel size per color channel. The sensor features both square and rectangular pixel modes with two adjacent lines of each type. Either of the pixel shapes can selected. Such a configuration is suitable for applications with poor lighting conditions or low sensitivity. Additionally, the dual-line approach, along with algorithms in the camera's FPGA, allows for real-time pixel binning using a combined voltage-and-floating-diffusion gate. This leads to an increase of pixel responsivity by almost 300 %. A combination of horizontal and vertical binning results in a resolution of 2,048 pixels and a pixel size of 15 x 15µm.

A Wide Application Range

The uniqueness of this product also lies in the scope of its applications. The line scan market has a wide range of applications with varying speed requirements. The slow speed applications such as sorting of vegetables, fruits, stones, minerals and trash can principally work well with a standard GigE interface (1000BASE-T) whereas the high-speed applications such as print and packaging inspection, road and railway track inspection are today based on interfaces such as CoaXpress or Camera Link. This approach explains the fact that the type of interface is determined by the application. The SW-4000T-10GE is based on a backwards-compatible 10GBASE-T interface platform. The backwards compatibility to NBASE-T (5GBASE-T and 2.5GBASE-T) as well as standard GigE (1000BASE-T) can be achieved with the JAI 10 Gbps platform. This approach breaks the conventional norm of an application defining the type of interface. With the backwards compatible approach, most of the line scan applications can be effectively covered.

Scanning Moving Objects

The combination of the GigE interface with prism technology gives an additional technological edge. Optical inspection of objects moving at unknown speeds can only be efficiently achieved by using prism technology. The single optical axis from the object to the camera and

> *"The single optical axis from the object to the camera and the splitting of light inside the prism offer the unique advantage of scanning objects moving at unknown speeds."*

the splitting of light inside the prism offer the unique advantage of scanning objects moving at unknown speeds. Further advantages of the prism technology over other line scan technologies include adjustable analog gain, digital gain and exposure time for every color channel. It is important to mention that the individual exposure time for each color channel is not a big advantage when it comes to line scan due to limited exposure time defined by the nature of line scan applications, i.e. fast-moving objects. The separation of light in the case of prism technology is carried out on the prism block. In this approach, the prism block consists of hard dichroic coatings which by nature are interference filters. The steep nature of these coatings results in lower spectral cross-talk which for R-G-B cameras would be defined as lower color cross-talk. The superior color quality in prism-based cameras is a combined result of these factors that leads to high color contrast and dynamic range.

HSI Color Space

The new camera is loaded with features on the camera FPGA that add further value to the end-user application. On-board 3D color conversions from RGB to HSI and RGB to CIE-XYZ provide the user with a color measurement option. The HSI (Hue, Saturation and Intensity) color space is an important one because it represents color similarly to how the human eye senses color. This color space is often used in image analysis for feature detection or image segmentation. The on-camera RGB to HSI being a one-step algorithm it works in real time. To give an application example, an RGB color space could be used for simpler tasks such as differentiating a red apple from a green one or a red LED from a green one. In order to differentiate two red apples or two red LEDs, a more sensitive color space is required. The differentiation in this case is not only based on the surface hue but also the depth of hue, i.e. saturation and the lightness or darkness in terms of intensity. Similar to HSI, XYZ is a three-dimensional color space which forms the basis for all CIE-based color conversions. In quality control applications such as printing and packaging, textile and tile inspection, the CIELAB color space is used. CIE-XYZ forms the basis of such a conversion which can be carried out on the camera head. Furthermore, the SW-4000T-10GE also allows an sRGB and Adobe RGB conversion. In addition to this, the user can also output a custom RGB gamut by using the on-camera 3x3 matrix, e.g. a specific viewing condition, illuminant, calibration data or specific application know-how can be inputted through the 3x3 matrix. The on-board FPGA processes the camera RGB with the 3x3 matrix to output a custom RGB. For applications with known inspection speeds, the encoder can be connected and set directly through the camera. The camera acts as a speed measurement device maintaining the vertical resolution in order to control the "squareness" of pixels. The encoder setting through the camera avoids the addition of daisy chain components and avoids any delay in multi-camera trigger configurations. The camera can also achieve higher speeds than 100 kHz if an ROI of the sensor is read out instead of the full 4,096-line resolution. With the windowing option, it is important that the ROI for each of the red, green and blue channels is the same.

The Charm of PoE

The camera also comes with POE (power over Ethernet) functionality. A single cable solution in machine vision cameras has its own charm as it also reduces the complexity of device handling. The POE on the new line scan camera is based on the IEEE 802.3at Type 2 standard. Even though there are no machine vision boards available on the market today that can support this kind of power requirement over Ethernet, the camera is well equipped for future. Nevertheless, it also has a dedicated 12-pin Hirose power supply as a solution for state-of-art applications. Design considerations have also been given deep thought. The positioning of components and heat dissipation from the camera has been designed in a way that - under tested and recommended operating conditions - no additional heat sink is required for full camera speeds working with a cable length of 100 meters and input voltage of + 24 VDC. In conclusion, the JAI SW-4000T-10GE is designed to add value in line scan applications by not only providing flexibility in inspection speeds but also by providing the best image quality combined with on-board intelligence and smart camera design. Part of the backwards compatible 10GBASE-T Sweep/Sweep + series are also a R-G-B-NIR and a R-G-B trilinear model.

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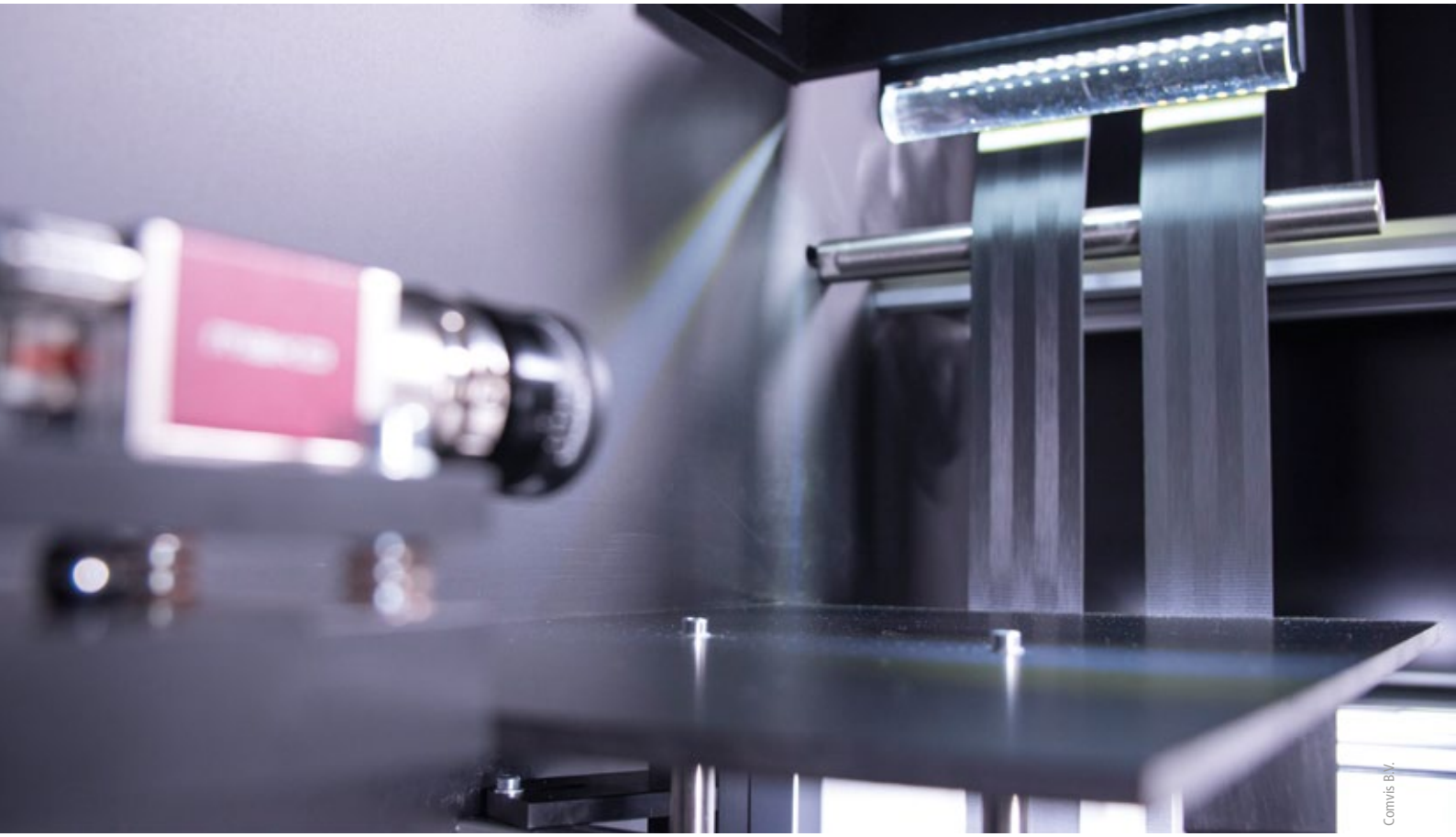


Comvis B.V.

No More Defects

Inline Quality Inspection of Textile and Industrial Fabrics

Industrial fabrics need to have specific characteristics according to industrial standards. Inspection units examine kilometers of textile to detect any defects affecting the reliability and quality of the fabrics.

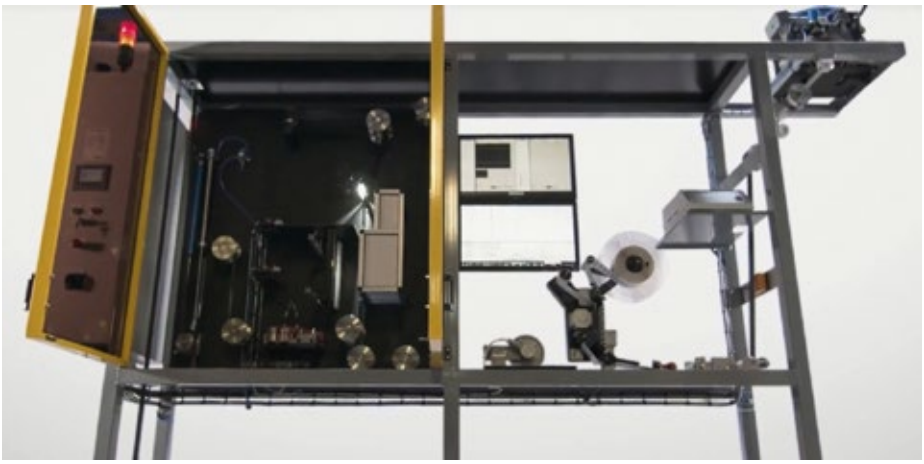
Textile is everywhere. It is one of the most versatile products used in almost every imaginable industry, from fashion and lifestyle to medical use or the automotive industry. Other examples are sunscreens, lashing straps, dog leashes or protective fabrics for outdoor sports. Every kind of textile has its own unique characteristics based on comfort, strength, absorbency, repellency, abrasion resistance, and breathability. In all of these cases the user has to be able to rely 100 % on the product's quality and the absence of defects. In the end, safety depends on the tensile strength or elasticity of a belt, rope or material. A faulty product could trigger fatal consequences. To maintain the specific characteristics of the fabric's quality, control and assessments in the production process are important elements for textile manufacturers. Yet, they are usually time-consuming and error-prone when carried out by the human eye.

High-Quality Images

For this purpose, Comvis, one of the leading Dutch companies in the textile industry, has developed the Texplorer software suite, a specialized vision software for the inline quality inspection of textile and industrial fabrics. The company´s vision inspection units that run the Texplorer software inspect both narrow fabrics (such as seat belt webbing, elastic belts, hoses, industrial belts for strapping/ lashing, etc.) and wide fabrics (such as such as screens, sieves, (medical) bandages, base layers, woven and non-woven fabrics) for spots, stains, broken filaments and agent servant defects.

The inspection units are equipped with Allied Vision's Mako cameras. Integrated into the software suite via the standard software for machine vision, Halcon, two Allied Vision Mako G-234 cameras capture

Mako G-234 cameras capture high-quality images of the inspected fabrics.



Comvis B.V.

The inspection units are equipped with Allied Vision's Mako cameras.

high-quality images of the inspected fabrics. The 2.35 Megapixel GigE cameras incorporate the Sony IMX249 CMOS sensor. At full resolution, the cameras run at 41.2 frames per second. With a smaller region of interest, higher frame rates are possible. The cameras deliver high-quality images of the fabrics, benefiting from the precisely aligned sensor. They can easily be integrated into inspection units such as Comvis´ system because of their small dimensions of 60.5 × 29.2 × 29.2 mm, including connectors. They also include Power over Ethernet (PoE), and thus can be operated via a single cable for power and data transfer. Stemmer Imaging B.V., Allied Vision's distribution partner in the Netherlands, has provided the cameras as well as the Halcon vision software for the fabric inspection system.

Detecting and Analyzing Defects

The Texplorer software analyzes the quality of the required specific characteristics in real-time. By analyzing the provided images through powerful image and data acquisition algorithms, the system captures the smallest defects that are the hardest to find. A graphical overview shows the running quality expressed across the last 1,000 m. Every type of defect is represented with a respective colored dot. If desired, all captured defects can be physically labeled and saved into a defect log file containing all the necessary data like time, position, production batch and defect image. The documentation of the detected defects guarantees full defect traceability and helps to improve the production process continuously. Kilometers of textile can be inspected in one go with a speed of up to 200 m/min.

100% Inspection

By using automated vision inspection units instead of relying on human vision, textile manufacturers can speed up their production process and increase the quality of their products. The management applications show real-time defect images and allow the operator to edit a protocol and adjust settings without the need to stop or slow down the production process.

With the Texplorer inspection units, textile manufacturers can guarantee that their customers will be provided with A-class products, 100 % inspected according to industrial standards, which is especially important when they are used for safety-relevant applications. "The chance that the seat belts in your car were inspected by the Comvis solution with Allied Vision's Mako cameras is 50 %," said Harm Hanekamp, Sales Manager at Stemmer Imaging in Zutphen, the Netherlands, pointing out the success of the globally marketed vision solution.

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Vision 2018 Hall 1, Booth 1D30

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Cheese Checking

Image Processing for Error-free Label Inspection

These days, food production nearly always entails a high degree of automation. To enable the error-free packaging of cheese, powerful machine vision systems ensure correct labeling.

Handling the labeling of cheese products for different international customers is an intricate process. When 150 different labels with varying information need to be inspected for up to 20 checks and at high band speeds, the automated inspection system has to integrate several high-performance components both on the hardware and software side.

Reading Cheese Labels Reliably

"For us, it is all about automation" is the motto of Kaiser engineering in Rheinfelden near Basel. According to Roger Schweingruber, deputy managing director, the company's core skills lie the area engineering special machinery and production equipment as well as robotic solutions, electrical engineering, and machine vision technology. This diversity enables us to supply a broad range of solutions for all industry areas including FDA-compliant designs for the food industry.

The engineering company has recently leveraged its experience in engineering food production equipment with a system that reads, checks and evaluates labels affixed to cheese packaging. Their customer specializes in the production and distribution of dairy and cheese products. "The labels on cheese packaging used to be checked solely for the presence of the barcode, while all the other information was ignored," says Roger Schweingruber, explaining the situation that existed until only a few months ago. "This was no longer acceptable for cheese producers, especially as cheese packaging systems now operate at such high speeds that only an automated check is possible. Cooperating with Fabrimex Systems, we developed a solution for this task with the result of a 100 % reliable check of all labels and data they contain."

Successful Teamwork

For many years, Swiss Fabrimex Systems that offers OEM and system solutions for automation and quality control in numerous sectors has been working with Kaiser engineering who source many of the automation components used in their bespoke turn-key systems from them, be it application-based industrial PC systems, image processing components, or measurement systems. Relying on their partner's recommendation, the team at Kaiser engineering integrates the selected machine vision components in the bespoke machinery and equipment. In addition, they program the systems for their customers, frequently drawing on their experience in robotics.

For many years, Fabrimex Systems has been the Swiss agent for the industrial cameras produced by the German company SVS-Vistek. What Thomas Graf, their sales manager, particularly appreciates about the company's cameras is, among other things, the broad range and high flexibility: "SVS-Vistek develops and produces high-quality cameras and is able to respond to special customer requirements very quickly and flexibly. The available camera models and ranges are very versatile in terms of their resolution, speed, interfaces and additional technical characteristics. We have made very good experiences with the cameras in numerous installations for our customers over the last few years."

The cheese packaging passes under the machine vision system from the left and is placed in transportation boxes after inspection.

With their dust- and water-tight IP67 body and the robust connector design, the SVS-Vistek Eco cameras are ideal for applications in the food production industry.

Optimally Configured Image Processing

As far as the systems for checking the labels on packaged cheese portions are concerned, the objective of the cooperation was to develop a machine vision system based on IP67-protected Eco 625 and Eco 815 GigE-Vision cameras with a resolution of 5 and 9 megapixels, respectively. They are fitted with the proven 2/3" and 1" Sony sensors. Depending on the requirements, the 12-megapixel version of this camera series is also used.

One of the special features of this camera range is the integrated two- or four-channel flash controller that can be operated directly via the camera. "This particular feature of the cameras saves users considerable time, space and money. Moreover, it is only necessary to use and synchronize a single SDK instead of two. This reduces resource requirements considerably," explains Thomas Graf. Roger Schweingruber confirms: "The resources and costs required to integrate these cameras in the system and the evaluation software were substantially lower than what we would normally expect. This is materially due to the cameras' I/O design and integrated flash controllers." According to Thomas Graf, an additional feature of the GigE-Vision cameras also resulted in the simpler and swifter engineering of the overall system: "These cameras support the safe-trigger system in which the trigger signal is shielded from any disruptions."

For Graf, a further argument in favor of the chosen cameras is their dust and waterproof UP67 body. It allows their use in food production applications without any further protective casing. The production and processing systems used in this industry must be regularly cleaned, in some cases using high-pressure water jets. With the IP67 characteristics of both the tube and the camera body, the Eco cameras are able to withstand these tough requirements. The M8/M12 connection design that is compliant with the field cabling standard ensures the necessary impermeability in such applications. "The combination of these characteristics makes the Eco cameras the prime choice for us," says Thomas Graf.

Numerous Different Labels

As the packaging and labels tend to reflect the light generated by the flash in view of the nature of the materials used, thus rendering the ensuing evaluation more difficult, the equipment manufacturer developed a tunnel-like indirect lighting unit specially optimized for this task and based on two LED lamps sourced from Effilux. The images gained in this way can be effortlessly evaluated using Matrox Design Assistant 5, which is based on the Matrox MIK imaging software. The entire image evaluation process is handled by a powerful fanless industrial Fabrimex PC.

"The system handles around 150 different label types. Depending on the type of cheese and the customer, the labels may contain different data. Accordingly, a database linked to the imaging system initially only provides information on the data that has to be checked and read on the label in question," explains Roger Schweingruber. "The data on each label is then transferred to the SAP system and stored." He mentions another special system feature: "In addition to many powerful imaging functions, every customer can individually decide which data should be printed on the label. This means that we have to design the imaging systems to be as flexible as possible, e.g. to permit non-alphanumerical evaluation as well." He cites the inclusion of weights in American units or the use of the Cyrillic alphabet for the Russian market as examples. "We achieve this by using Matrox Imaging's parameterizable image software Design Assistant 5 with integrated recipe management."

The requirements for image processing are demanding: With a band speed of around 1 m/sec, there is only a maximum of 150 ms to read and evaluate two codes and to perform up to 20 additional checks of texts, date, logos or dimensions on each package. Possible errors include missing or incorrect labels on the packaging or illegible, omitted or incorrectly evaluated labels. "Currently, the line is halted as soon as five errors are detected so that a manual check can be performed. However, looking forward, we want to completely automate this step as well," explains Roger Schweingruber.

In addition to the currently used four machines another project involving a 47 megapixels camera from SVS-Vistek is planned for the future.

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SVS-Vistek Eco cameras provide the basis for checking the labels on the cheese packaging.

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Vision 2018 Hall 1, Booth 1E71

Laser-assisted Weld Seam Inspection

1,500 Reliably Inspected Welds Per Audi Sports Car Body

In the body production of the Audi R8 sports car factory a laser projection system assists the staff in the manual inspection of around 1,500 welds per body. This has to happen within the cycle time to prevent delays in the manufacturing process.

Manual production and quality inspection in the production of high-quality car bodies – this is what you find in the "Audi Böllinger Höfe" factory of Audi Sport. Here, the Audi R8 super car is built almost entirely by hand. The body construction is also a very special factory operation. The R8 factory is designed for small series production and great variety: "Our highly qualified colleagues build the cars with the greatest of care. They meet the highest quality standards," says Felix Knoll, Head of Body Construction at Audi Sport.

100% Control

In the first step, specialists weld the front end, the centre floor and the rear end from aluminium castings and extruded profiles, then connect the three modules to the substructure. Robots take over the cold connections. The subsequent quality control of the approximately 1,500 welds per R8 body is also carried out by the employees. The fact that even with this procedure it was necessary to carry out a 100 % control of each individual weld seam with absolutely reliable detection of faulty connections is something that was indispensable according to Knoll: "A body with just one single unclean weld seam no longer meets our high Audi quality standards and is therefore not suitable for sale."

To answer the question of how to perform a 100 % check of all welds every day, a colleague of Knoll's conducted technology assessment and research across the Group and investigated various technologies for this purpose. The problem was clear: How to check an aluminium weld on an aluminium background? "In our experience, optical methods such as image processing systems which match the whole with a given image, have not been effective previously for this kind of task," said Knoll. "Other technologies such as computed tomography, MRI or augmented reality were also possible candidates, but in the end they also proved to be inappropriate. In the end we opted for a laser projection system from Z-Laser Optoelektronik, considering the many criteria that have to be met."

Numerous Criteria

The criteria mentioned by Knoll included the requirement that the system had to make it possible to check every weld of every single body within the cycle time in order to avoid delays in the production flow. In addition, it was necessary for the implementation period to fit the conditions in the production of the R8 models, as Knoll explains: "The implementation of the system had to be feasible in terms of time and space. The space in such a plant is naturally always limited. The main difficulty here in our body con-

Through a defined, standardized test procedure each weld is always queried at the same time.

Display of welds on the body with one of the six laser projection systems in the background.

struction was that we had to integrate the system into existing plant, i. e. the space for such a laser cell was limited and we had to realize the system with the available space. That's why we installed suspensions, lifting platforms and peripherals such as power and data cables so that our partner Z-Laser would be able to put its laser system into operation without any problems." In addition to these technical and space constraints, another prerequisite for the realization was that the system had to remain within a specified budget.

"However, in view of the large number of welds and the required reliability of the quality inspection we definitely wanted to provide our employees with assistance in testing all welds", Knoll emphasizes. Already in the technology search phase, he and his colleagues came across the Freiburg-based company Z-Laser that has been specializing in the production of laser sources for innovative customer applications for several years. "At the beginning of 2016, Z-Laser was on-site with a test device for demonstration purposes, and we were quickly convinced that the system could meet our requirements." Detailed system feasibility studies were followed by final system selection and assembly, and in October 2016, the order was placed.

Subsequently, the company assisted Knoll and his team with the integration of the laser system into the plant as well as with its programming. In April 2017, the system was put into operation, inspecting the bodies of the Audi R8 Coupe as the first model variant. Only a short time thereafter the complete series program could be displayed on the system.

Laser Projection Shows Test Points

The Audi engineer describes the course of the test as follows: "We map our 3D body dataset in the system, and the laser system projects this dataset onto the actual body from different directions via a total of six LP-HFD2 laser projectors. For this purpose, the bodies to be checked are first sent to reference points via the provided conveyor equipment. Afterwards, the employee selects the correct position and the current model and can then click through the steps of the inspection via a remote control of the laser system similar to a PowerPoint presentation. Depending on the position of the weld, a suitable laser projector then projects green laser lines onto the body, thus indicating the target position with the start and end point of the welds to the employee. On this basis he can compare the projection with the actual weld and easily recognize whether the single weld is present and whether the given length is correct. However, the quality of the weld must be assessed by the employee himself." A green laser source was chosen to produce a maximum brightness impression on the viewer.

In the production process, three employees are responsible for the visual inspection. One checks the welds using the Z-Laser projection system. The other two from the so-called Quality Control Group (QCG) inspect these visually in different stages of production, so that each volume is covered in the 4-eye principle. According to Knoll, employees need to be very experienced in these tasks and not only have to know all production volumes, but also their location in order to be able to identify faulty processes and correct them if necessary.

Efficient Solution

Knoll is very satisfied with the solution that has been running smoothly for several months now: "We have become significantly more efficient with our test procedure and can now integrate more test volumes into the QCG employees' workflow, which were previously controlled elsewhere."

Among other things, the Audi engineer finds it very useful that thanks to this application, "with the help of software we can decide at which time and in which position of which laser a certain weld seam position is displayed. We have thereby a defined, standardized test procedure, i.e. every weld is always queried at the same time." This way, it is possible to quickly and easily train new employees on the system so that they can independently carry out the inspection of a body.

The system shows a high degree of flexibility for the adaptation of test procedures, e.g. if a new model or model changes lead to a change in the welds, according to Knoll: "The CAD data of the volumes to be tested serve as a basis. This dataset is assigned a time in the test procedure and defines in which position and from which laser the projection should take place. Using a small program, new data packets are converted into projection data. If they are small volumes, e.g. a modified weld, we are able to implement the corresponding change in the test procedure within a few minutes. In a new model, the definition of the test procedure and the definition of the projection without fine-tuning requires a workload of about two to three weeks. However, we can implement this without further external support," emphasizes the project manager an important advantage of the system.

Knoll rated the collaboration as very good and problem-oriented: "The project has been optimized with helpful suggestions from Z-Laser and is now an integral part of optimizing the manual inspection of welds in the production of our R8 models."

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More information

See video https://youtu.be/DhQNeCFjC_8

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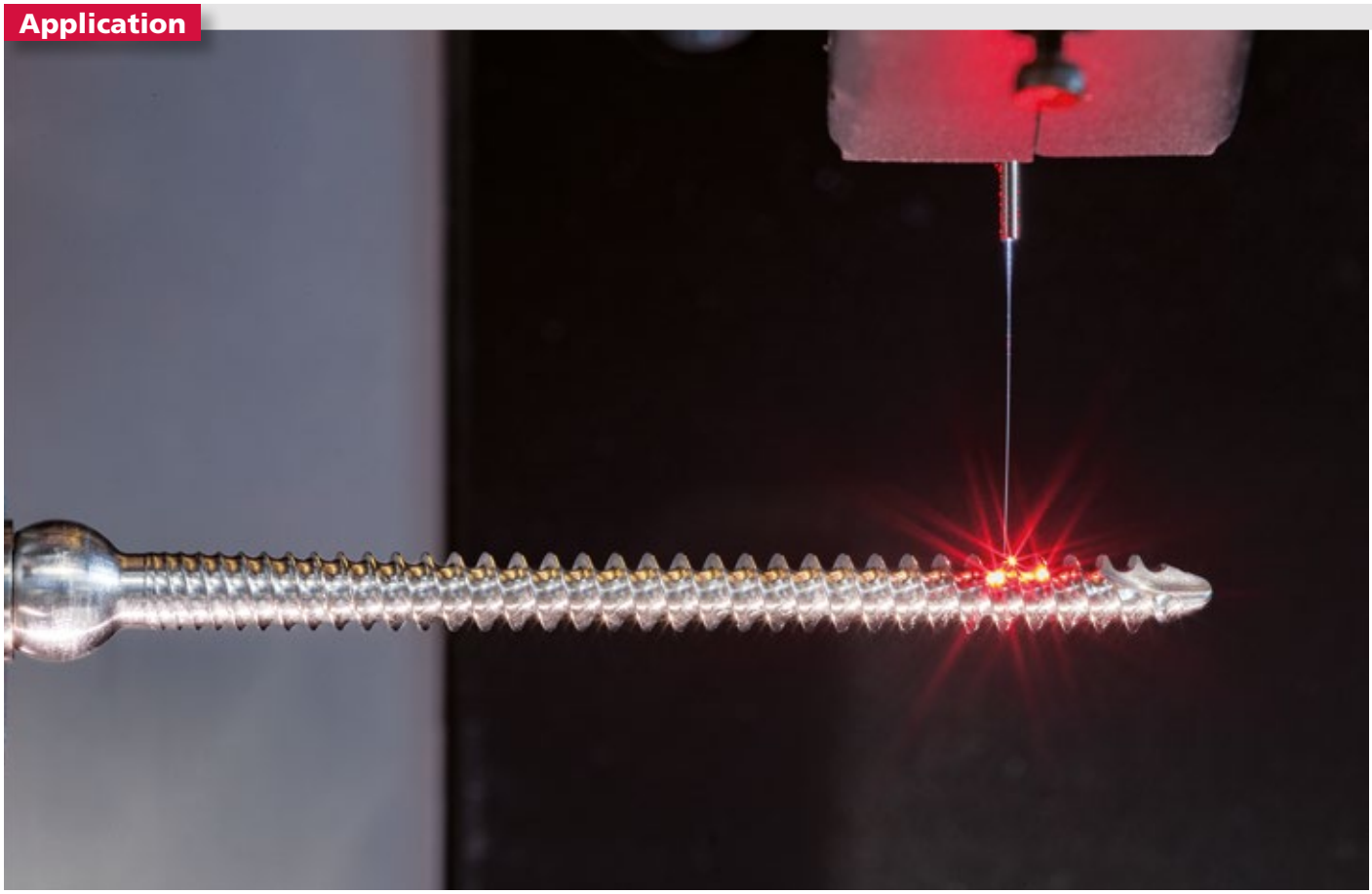


For the Good of the Patient

Multisensor Measuring Technology for Surgical Instruments and Implants

A high-precision multisensor coordinate measuring machine ensures that the demanding quality requirements in the production of sophisticated medical instruments are met.

No other industry is subject to as much regulation or high customer expectations as the field of medical technology. In order to meet all of the quality requirements, the international medical technology company Gebr. Brasseler uses the latest measurement technology, which feeds the company's digital process chain on the software side. By networking with CAD, CAM, and CAQ, the medical technology manufacturer is able to produce top quality and still get to market quickly.

For more than 90 years, Brasseler´s brand name Komet has stood for high-quality dental drills. With these rotating instruments and other dental tools, the company became one of the global leaders in innovation and quality. From this strong position, Gebr. Brasseler developed Komet Medical, a division that manufactures rotating instruments, saw blades, immobilization and navigation pins, and other products for orthopedics, ENT, and neurosurgery, in the 1990s. Starting in the fourth quarter of 2017, the scope of manufacturing technology has expanded to include the spinal implant product group. Komet Medical will only be a contract manufacturer in this area, however.

While Komet Medical branded products are sold as catalog items by distributors all over the world, the division, which has been managed as a separate business unit since 2013, is also a production partner for numerous PLMs (private label manufacturers). Jens Haverkamp, General Manager of Komet Medical, explains, "For some PLMs, we now deliver complete sterile-packaged products bearing their label. This is a sign that our quality is truly first-class and that customers trust our entire process chain."

No wonder, as Brasseler works according to a comprehensive quality management system certified to the EN ISO 9001 and EN ISO 13485 standards. Regulatory requirements, however, have grown tremendously in recent years. In order to reliably meet all the specifications, the development process often takes up to a year, starting with a risk analysis per DIN EN ISO 14791. "This places tremendous pressure on project and product management," says Jens Haverkamp. "Ultimately, product launch times should be as soon as possible for cost reasons."

Optimized Processes Under Industry 4.0

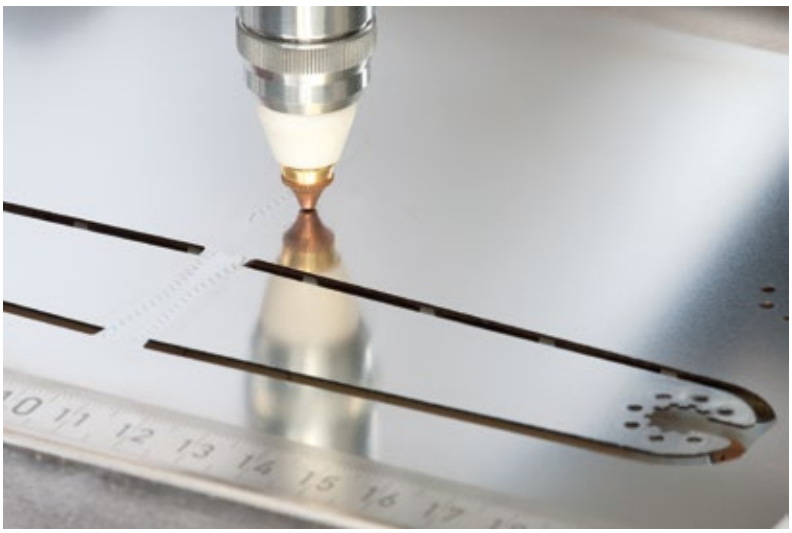
The company reacted several years ago and optimized the entire process, from product development to shipment of finished parts. The term Industry 4.0 describes production that is self-organized and monitored to the greatest extent possible. The optimization process also included quality assurance and measurement technology, which in Jens Haverkamp's view will take over a large portion of the manufacturing process in the future. "In order to meet all the specifications, we need traceable and reproducible processes at all times. This can only work with high-precision measurement technology that covers the entire process and is integrated in our digital network."

For a long time now, Brasseler has partnered with Werth Messtechnik, a leading company in coordinate measuring technology with optical sensors, multisensor systems,

and X-ray tomography. Many ScopeCheck and VideoCheck multisensor coordinate measuring machines are in use in the Lemgo facility. Jens Haverkamp explains why, "Multisensor systems are indispensable in order to capture the various features, especially for our rotating and oscillating instruments."

Komet Medical, where such sophisticated instruments as the high-speed drills for neurosurgery and the new spinal implants are produced, uses the Werth VideoCheck FB DZ, a high-precision multisensor coordinate measuring machine with a fixed bridge design and air-bearing technology. Besides an image processing sensor with a fixed magnification, the patented Werth Zoom is equipped with an integrated Werth Laser Probe optical distance sensor. The Werth Fiber Probe, also patented, makes it possible to measure extremely small geometries with high tactile accuracy. To find the core diameter of a twist drill, metrologists at the medical manufacturer use the patented Werth Contour Probe.

Axel Pieper, Group Lead for Quality Engineering, explains, "We derive the need for measurement systems from the required measurement tasks in each case. When highly accurate measurements or multisensor systems are required, we typically use the VideoCheck or ScopeCheck machines for both process-integrated measurements and final inspections." For the saw blades product group, which has entirely different measurement tasks, the manufacturer´s quality assurance team uses the latest machines in the FlatScope series. "The FlatScope was the only measurement device that was able to meet our requirements," says Axel Pieper.



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Demonstrable high quality is critical to the market success of Komet Medical saw blades.

Besides the Technology, the Overall Concept Is Critical

At Brasseler, the required measuring equipment is always discussed with the team. For new acquisitions, the decision is made unbiasedly using defined key factors, one of which is a suitable overall concept. Quality expert Pieper explains, "The measuring machines and their software need to be able to be integrated in our structures, including the digital ones. For example, we need a software system, which has to be able to exchange data with our various systems."

This is because the decision-makers of the company have designed the process chain to be completely digital in order to reduce time to market. A 3D volume model is created in the CAD system, from which the NC programs required for machining are derived in the CAM system. In parallel, the volume model is used to program the measurement sequence offline in the WinWerth software. The measurement technicians at Komet Medical are thus able to create a measurement program for a new product before a single workpiece has come off the machine. Offline programming thus speeds up production starts and keeps the measuring machine free for other tasks.

The measurement software includes a CAD as well as a CAQ interface. "The data exchange with CAQ software means that we can use part of the measurement program to create the inspection plan. The dimensions and tolerances are taken from the measurement program," explains Pieper.

Data Exchange Defines the Future

Jens Haverkamp considers the cooperation with Werth Messtechnik to be the way of the future. "We need reliable, long-term partners like Werth to provide quality products, which can be integrated into our digital network." He especially prizes the willingness of his measurement technology partner to work closely with Brasseler as an end user, as well as with grinding system manufacturers and CAQ software providers. Projects take much longer nowadays due to regulatory requirements, especially with large partners in medical technology. This produces close partnerships that last many years and often lead to identical measurement technologies being purchased and used. "Unlike in previous times, data exchange is often much more open, which strengthens both partners in the end," asserts Haverkamp confidently. For him and for Komet, this already means, "Our customers know what machines we work with and what we measure. We even share measurement programs with our project partners. This eliminates incorrect measurement strategies, so the measured values and results can be discussed immediately."

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Using modern measurement technology, even the strict requirements of the medical industry are met.

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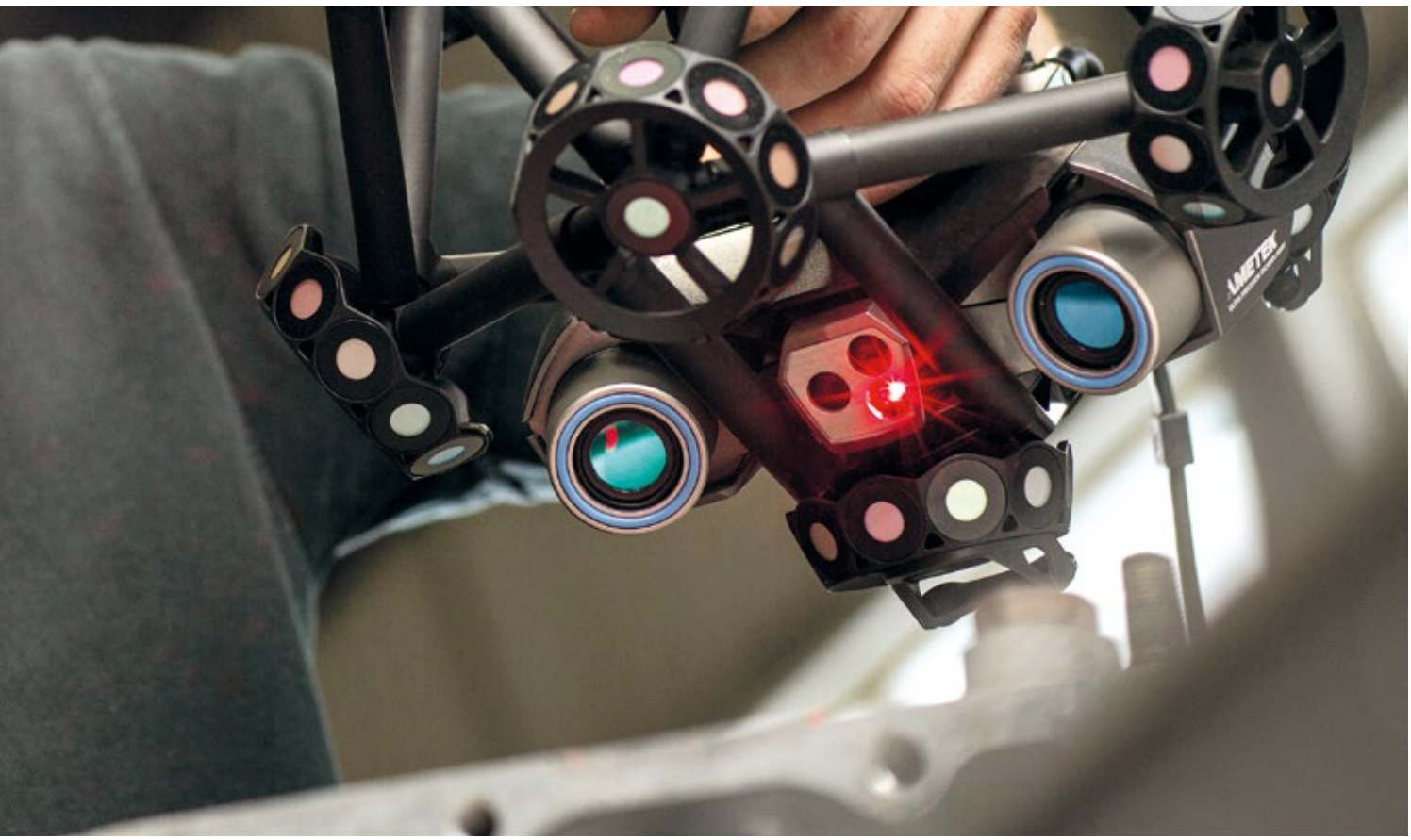

Even More Accurate

Acceptance of 3D Scanning in Quality Control

Due to its high accuracy, probing gained the approval of quality control and quality assurance professionals over the last few decades. However, the major players in the industry are now moving toward 3D scanning, which was once reserved for product development.

Why are today's industry experts placing their trust in 3D scanning and granting it a significant role in quality control? The primary reason for placing probing and 3D scanning at the same level of preference is that the latter has reached a level of accuracy that approaches traditional probing methods. In addition, 3D scanning provides quality control and quality assurance professionals with more data, more details, and more information, which also motivate them to opt for this technology.

What Led to the Increase in 3D Scanning Accuracy?

The capacity of a 3D scanner depends on the components inherent in its design. Cameras and advances optical calibration techniques, which are important components of a 3D scanner, have acquired a significant resolution, while light sources have also become better defined. These improved components result in higher accuracy. Nevertheless, 3D scanning is not going to stop improving. The same as computers, innovation will continue to respond to industry challenges.

Need for Automation

The industry of tomorrow is moving toward automated quality control. In Industry 4.0, where the entire manufacturing process is connected, integrated, and automated, 3D scanning is better suited than probing to inspect parts as they are manufactured. Indeed, 3D scanners can quickly capture a lot of data, which are essential to the 4.0 manufacturing process.

Expertise Required

A coordinate measuring machine (CMM) requires the intervention of a high-quality workforce with both the training and the experience to maneuver a probing system. These experts, who are essential to the proper functioning of probing tools, are sometimes difficult to find and keep, thus undermining the quality control process. With the latest 3D scanners, however, operating or programming experience is not specifically required. 3D scanning, therefore, is accessible to all.

Design-oriented Geometry

We live in an era in which design is very important. Companies want to distinguish themselves from the competition by their design-oriented geometry and form. They develop parts with various shapes, sizes, and finishes. Inspecting those complex geometries requires a multitude of high-quality data easily accessible with 3D scanning.

Now that the range of accuracy granted by 3D scanning exceeds the threshold required for quality control and that its development helps to respond to industry challenges, all the benefits of the technology, such as its

Flexible quality control: Combined scanning and probing for the shape inspection of a car rim

Portable HandyScan 3D scanner scanning a car body part

speed, ease-of-use, and portability, can be applied to improve the quality of products and the work of quality control professionals.

Portability

3D scanners are tools designed to be portable. They can be moved on the production floor, go where the part is, and perform inspections in unstable environments. Unlike fixed CMMs, they do not require a dedicated room, do not have to be fixed to the floor or placed in a controlled environment.

With portable measurement tools, the manufactured part does not have to be brought to the measurement system. Therefore, it is possible to control the preliminary and intermediate stages of the production process as well as all the small deformations that can occur during the manufacturing steps. With probing, however, it is more complicated to understand – due to the lack of data - the effects of a stamping or a folding that could have deformed or twisted other sections of the part.

Ease-of-Use

With a 3D scanner, the user simply has to point and shoot. Not only is the tool easy to handle, but also its data is simple to interpret. A colormap provides a quick and easy visualization of the part deformations. This feature enables users to easily see if a part is within the required tolerances, or if it has been deformed or twisted. Measurement points are obtained and visualized more easily than with a CMM, which does not provide a visual interpretation and takes time to capture, analyze, and portray the information. As a result, 3D scanning allows for parts to be adjusted easily and quickly.

Speed

The ability of 3D scanners to capture a lot of points combined with the ability of computers to process a lot of data makes calculations much faster. This increased capacity will not stop, as the speed of data processing will continue to increase with the innovation and evolution of the technology. Indeed, the sensors that comprise a 3D scanner already offer better accuracy and better resolution than those developed a decade ago. Added to this are the continued improvements to computers' processes and capacities for analysis. This synergy suggests further developments and innovations that will surely surprise us.

3D Scanning: Technology of the Future

Probing is already a mature technology, while 3D scanning has enormous potential, as many engineers work to improve, develop, and innovate it. It's the technology of the future. Although the levels of resolution and accuracy are already high, they will continue to evolve, which will bring even more data, more details, and more information. This will open the door to inspecting even more complex parts. We are on the increase slope of the innovation curve. One day, we will surely be able to control 100 % of parts. Quality control calls for inspections on 100 % of dimensions on 100 % of parts. The more you control parts, the less you have to rebuild them. This means fewer material losses, fewer rejections, and fewer returns. We are on our way to perfect parts.

Return on Investment

Compared to fixed CMMs, 3D scanners are not only cheaper to buy, but they also measure faster and require less expertise. As a result, less time is spent on each part, with less specialized resources, while spending less money on technology. The vast majority of inspections can now be performed with 3D scanning: quickly, directly where the part is without having to move it. Only very high tolerance inspections can be directed to and measured with probing.

A 3D scanner is an essential tool in the quality control toolbox. It is not meant to replace everything, but it is there to offload the CMM, to do more with complex geometries, and to reserve the CMM for the few points that require a critical accuracy. This is how the alliance of the two technologies provides a perfect solution. Since the majority of inspections can now be performed with a 3D scanner, why not clear the majority of inspections with a tool that offers an impressive ROI and leave delicate and important features to probing. This complementarity between 3D scanning and probing proves to be a winning combination – until 3D scanning reaches and surpasses the level of accuracy offered by probing.

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Radiating Quality

Computer Tomographs Optimize Production Processes

Nowadays, 3D volume data can be gained directly in or in immediate proximity to the production line. This has a positive effect on process optimization.

For many years, X-ray systems have been enabling companies to look inside their components. Until now, only 2D X-ray systems have been used on the shop floor because they offered the necessary robustness and speed. However, it has since become possible to acquire 3D volume data at-line or in-line. BMW and the Austrian high-pressure die casting and injection-molding manufacturer TCG Unitech demonstrate how the technology can assist in optimizing manufacturing processes.

In order to ensure quality and even improve processes, more and more companies are increasing the number of inspected components or even performing 100 % inspections. For many products, manufacturers either want or need to examine internal component structures with a computer tomograph (CT) to rule out any potential defects. Fast-paced manufacturing often makes time-consuming measurements in the measuring lab unviable, because a CT inspection generally takes between 10 and 45 minutes. “Once you factor in the time needed to transport parts to the measuring lab, it clearly takes too long to inspect a lot of components without slowing down production,” says Dr. Torsten Sievers, Head of Application Engineering in Zeiss´ X-ray division. For this reason, companies often use 2D radiography to perform inspections on the shop floor. While this method also involves X-raying the workpieces, the results only tell technicians whether a part is good or not. Information about the size and location of defects is still limited. Quality-conscious companies tend to filter out suspicious parts in large numbers, for example when pores, i.e. air pockets in the metal, are visible.

Optimized Decision-making at BMW

Not every deviation from the CAD model or varying nominal and actual values are necessarily a problem. “It all comes down to whether or not the detected deviation will later on limit functionality,” says Sievers. In order to optimize decision making, Bayerische Motoren Werke (BMW) has been performing in-line measurements using a computer tomograph, also known as a CT scanner, from Zeiss. The objective is to find out whether the cast parts contain air inclusions that might limit functionality. “This is a world first,” says Sievers. Still, he has to admit that such prominent customers do not usually reveal specific figures confirming their monetary benefits.

Yet, for Sievers, who holds a Ph.D. in physics and was closely involved in the implementation of the Zeiss VoluMax, there is “no question that using this system has paid off for BMW.” He cites two particularly important benefits. Creating 3D volume models with the CT scanner makes it possible to precisely identify the position of pores in the cylinder heads. The car manufacturer can then make a well-informed decision concerning whether or not the unfinished part should be machined further or melted down. This is why, thanks to the CT system,

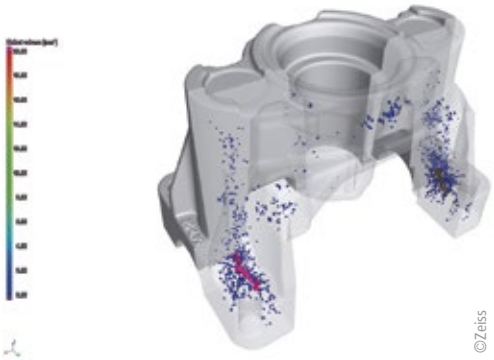
> *"The CT scanner helps prevent functionally relevant defects before they occur."*

©Zeiss

A robot loads the Zeiss VoluMax with the parts to be inspected automatically. The robot places cylinder heads with normal measurement results on the conveyor at the right.

the rate of so-called "pseudo parts" has been reduced, i.e. those parts that have mistakenly been filtered out and melted down again. This also means fewer slip parts, since the CT scanner can detect a wide range of defects. The term slip parts refers to those workpieces that "slip" through quality assurance, require expensive machining and are ultimately downgraded to rejects during a subsequent quality assurance check.

In addition to the time and money saved, Sievers explains that using the scanner in combination with the Zeiss PiWeb quality data management software has also had a second key benefit: optimized casting processes. Since exact defect positions are identified, the decision which molds have prematurely worn out and must be replaced earlier than anticipated can also be made earlier. In other words: the CT scanner helps to prevent functionally relevant defects before they occur. All of this is possible even



©Zeiss

Semi-transparent visualization of a virtual component. The color-coded display indicates the size of the blowholes.

though the scanning speed is just a fraction of the normal time required for a CT scan, thereby limiting the level of detail in the image. "But the level of precision is more than sufficient to check the four relevant characteristics on the cylinder head – residual sand, pores, bead wire breaks and contour errors," says Sievers.

A CT Scanner on the Shop Floor

The Austrian company TCG is also optimizing its casting processes with a CT scanner, albeit not the same model. The reason: in this case the CT must provide extremely precise results to eliminate the need for multiple measuring machines. This is why the measuring machine is not installed in the production hall itself. Instead, it can be found in a small room just a few meters away from the die casting machines. For David Demmelmair, Head of Quality Management, and Rene Klaffenböck, Head of the Lab team and Environmental Officer at TCG, the Zeiss Metrotom 1500 purchased in 2016 was a lucky find: "We can now quickly, and most importantly, reliably, determine whether the porosities detected are air pockets or shrinkage. This insight enables our die casting team to make the right adjustments to the machines," says Klaffenböck.

The initial results have confirmed that the engineer's calculations were correct, even though Klaffenböck is still waiting for the exact figures of the reduction in scrappage because the machine has only been in use for a short while. Klaffenböck explains that it is important to develop a good understanding how to properly use the CT. He and his colleagues spent months developing measurement strategies that ensure "our CT results are comparable to those we get with other measuring systems and methods." For example: To adequately assess visible defects in the volume model, Klaffenböck had the suspicious areas on the test object ground down layer by layer and studied under a light microscope. The engineer has filed the results and what his team has learned in innumerable folders. And that's not all. The records also contain the series of measurements for positioning the cast parts in the CT scanner. The measured components are generally not the same size and do not have the same thickness, which requires experienced metrologists to ensure that the workpiece alignment delivers an optimum result in the CT scanner. Thanks to the statistical evaluation for in-series testing of the cast parts the quality assurance managers know how much time is required to get the die cast machines up and running. Klaffenböck illustrates the competitive edge his company now enjoys thanks to their expertise: "Being an early adopter of this new technology we have a two- to three-year lead in our industry." The engineer is confident that this know-how will ensure the site's long-term success.

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Be Visionary

In the run-up to Vision – World's leading trade fair for machine vision – from November 6 to 8, 2018 in Stuttgart, inspect spoke with Florian Niethammer, Team Leader at Landesmesse Stuttgart, about the current state of preparations as well as what visitors and exhibitors may be looking forward to.

inspect: The vision industry in general is booming: According to VDMA, the sales growth in Germany amounted to 18%, and to 12 to 14% in Europe. To what extent is this reflected in the registrations for the show? Are you maybe even expecting a new exhibitor record?

F. Niethammer: We are already full of anticipation and confident that we will be reaching our self-set objective of 450 exhibitors at this year´s Vision show by the beginning of November. This would be a new record! The show will be occupying more space than ever before, and for the first time, both the foyer of the L-Bank Forum (hall 1) and the circumferential gallery will be occupied by exhibitor booths. Ergo we can definitely say that the industry boom is clearly reflected at the world's leading trade fair for machine vision.

inspect: How is the trend towards internationalization going to continue? How large do you estimate the share of foreign exhibitors, and which countries stand out?

F. Niethammer: The share of international exhibitors is continuously rising. As per today, more than 60 % of exhibitors will be arriving from abroad, this is a new record, too. Companies from the US and Canada are traditionally leading, followed by suppliers from China that has shown considerable growth during the past years. Moreover, the UK, Japan, France, Switzerland, the Netherlands and Taiwan are also strongly represented.

inspect: Machine vision is penetrating a rising number of industrial and non-industrial application areas. Are there new companies or entirely new industries that will be presenting themselves for the first time at this year´s vision show?

F. Niethammer: The constantly growing applications areas and the stronger awareness of machine vision as a key element of Industry 4.0 are attracting new players who want to position themselves both in the market and at Vision show 2018. On the one hand we are seeing a new bundling of resources resulting from mergers & acquisitions, on the other hand there is a multitude of new companies in the machine vision industry that will be using Vision show as a presentation platform for the first time this year.

inspect: Topics like Embedded Vision or Deep Learning have been dominating the relevant headlines lately. Will this also be the case for Vision 2018? Which additional main topics are you expecting?

F. Niethammer: Technological innovations are the DNA of our trade fair. Therefore, 2018´s motto is "Be visionary!" Innovative products, visionary technologies and trending topics of machine vision, like Embedded Vision, Hyperspectral Imaging, and Deep Learning are clearly in the focus. Embedded Vision, i.e. compact imaging systems based on high-performance computing platforms that are directly integrated into devices, enables new, exciting fields of application. Various exhibitors are intensively concentrating on this subject.

> *“We can definitely say that the industry boom is reflected at the world’s leading trade fair for machine vision.”*

Some of them will be at the show for the first time. There will also be a multitude of companies that will be presenting Deep Learning software, and there will be a dedicated short seminar on this type of product within the scope of “School of Vision.” In addition, we are considering Hyperspectral Imaging a technology that is gaining presence at the fair. But there will also be a wealth of innovations in other areas of machine vision.

inspect: Food & Beverage has already been a special topic at the fair in 2016. This year, the show for agricultural technology Intervitis, Interfructa, Hortitechnica will be taking place in parallel with Vision. Are you expecting to benefit from synergies?
F. Niethammer: Definitely. This is why we will again be highlighting exhibitors that bring special competences in the Food & Beverage industry as a user industry. The same applies to the areas Traffic and ITS where specialized companies will be exhibiting under the title Traffic Vision. In parallel to the fair we will also be having two interesting events: as stated above Intervitis that deals with viticulture and fruit and berry growing technology. We are seeing a high potential for its exhibitors, especially developers, as users of vision technology. In addition, Composites Europe fair that deals with the entire process chain of the composites industry will be taking place concurrently. The spectrum of its visitors, e.g. from the engineering and automotive industries, also has promising overlaps.

inspect: Besides the exhibition there will surely be a comprehensive framework program. Which of the highlights would you recommend to the visitors?
F. Niethammer: The Industrial Vision Days are probably the largest lecture forum for machine vision worldwide. This is one of the highlights exhibitors and visitors can expect. We are organizing it together with the VDMA industrial image processing. International machine vision standards will again be represented by a special EMVA show case. I would also like to highlight two subject areas: The Integration Area where system integrators and solution providers will be exhibiting, and the special area IPC 4 Vision area for providers of industrial PCs.

inspect: Finally, do you have an insider tip for the visitors?
F. Niethammer: Plan ample time for your visit because what makes Vision so unique are the wide-ranging networking events organized by exhibitors and partner associations some of which already start on the evening before the fair.

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Bildquelle: Framos

Vision 2018 Preview

Vision Stuttgart, November 6 to 8: Be Visionary!

Innovative products, visionary technologies and trending topics of machine vision, like Embedded Vision, Hyperspectral Imaging, and Deep Learning are clearly in the focus of this year's show in Stuttgart. While many renowned companies will be presenting their solutions in the current core areas, there are additional focus topics worth having on the screen, such as illumination, deep learning, and the latest objective developments.

LED-based Lights

Hyperspectral imaging can be used to detect the chemical composition of objects and therefore distinguish, for example, between plastics which appear very similar on the outside. Suitable illumination is essential for these systems. "In particular, users from the area of food inspection are eagerly waiting for special multispectral or hyperspectral illumination based on LEDs," said Sophie Perrot, an illumination expert at Stemmer Imaging. "The existing systems work with halogen lamps which produce a great of heat, which is a hindrance when using multispectral machine vision in the food industry. LED-based illumination will greatly extend the application area of machine vision systems, especially in this segment."

Intelligent Lighting

Another current trend in the area of illumination technology is called intelligent lighting. The objective here is to ideally exploit the reserves of illumination systems and therefore also use them in a more efficient and economical way. "Intelligent lighting can be used to monitor illumination systems and is therefore a step towards Industry 4.0," said Sophie Perrot from Stemmer Imaging. "Since the technical properties and the dynamic application data of illumination are permanently available in the system, the user can be informed in good time about decreasing lighting levels or other important changes."

Deep Learning Solutions

Representing a subdomain of machine learning and artificial intelligence, deep learning systems follow a technological approach that is fundamentally different from current machine vision techniques. "These systems employ neural networks," explained Vassilis Tsagaris, a Vision exhibitor and the CEO of Irida Labs. "The term 'deep learning' refers to the typically large number of hidden layers such networks contain." Systems based on deep learning structures are unique in their ability to "analyze huge volumes of digital image data, which makes it possible to train them to recognize models of certain objects" offered Dr. Olaf Munkelt, managing director of MVtec Software and another veteran Vision exhibitor.

Focus on The Latest Objective Developments

"There is a clear trend towards larger sensors, smaller pixel sizes and higher resolutions in industrial cameras. This trend is also having direct impacts on the objectives used here," said Nina Kürten, Assistant Manager CCTV and Machine Vision at Fujifilm Optical Devices Europe, describing a current development. As one of many examples of these application areas, she mentioned robot-controlled 3D cameras or scanners which are used, for example, to measure body parts in the automotive industry. Dr. Boris Lange, Manager Imaging Europe at Edmund Optics, confirmed this development: "We are seeing enormous interest in our objective series for harsh environmental conditions, either for use in robotics or in autonomous driving or in 3D metrology."

More Special Developments

According to Andreas Platz from Machine Vision Product Management at Stil Optics, "The market is aiming for increasingly more special objective developments. Individual optical and mechanical designs for customer-specific applications are gaining ground in Europe. They also enable medium-sized companies to survive against Asian competitors." Moreover, there is a trend towards fast focusing with liquid lenses.

Enjoy the Diversity!

Looking at the diversity of this year's show, you better allow enough buffer time in your schedule for all of the exciting new developments in the machine vision industry. Enjoy your time, and we're looking forward to seeing you in Stuttgart!
www.messe-stuttgart.de/vision/

Vision Product of the Year Award Winners

The Embedded Vision Alliance announced the 2018 winners for the Vision Product of the Year Awards at the Embedded Vision Summit. The Awards recognize the innovation and excellence of the industry's leading technology and end-product companies that are enabling the next generation of machines that see.

The winning entries for the inaugural 2018 Vision Product of the Year Awards are:

- Best Processor: Aimotive Aiware
- Best Camera: Intel Realsense Depth Cameras: D415/D435
- Best Software or Algorithm: Mathworks GPU Coder
- Best Automotive Solution: Algolux CANA
- Best AI Technology: Morpho Softneuro
- Best Cloud Technology: Xilinx Machine Learning Suite
- Best Developer Tools: Aimotive Aisim
- Best End Product: 8tree Dentcheck

The Vision Product of the Year Awards are open to all Embedded Vision Alliance Member companies. Entries are judged on innovation, impact on customers and the market, and competitive differentiation. Judges for the 2018 Vision Product of the Year Awards were Steve Glaser, Managing Director of Copia Growth Advisors and Executive-in-Residence at Plug and Play Technology Incubator; Dr. Chris Rowen, CEO of Babblabs and IEEE Fellow; and Peter Shannon, Managing Director of Levitate Capital.

www.embedded-vision.com

Innovation Award for Flir Systems

Flir Systems received a Technology Innovation Award for its Optical Gas Imaging (OGI) cameras, the GF320 and GFx320 at the recent Oil and Gas Methane Leadership Awards surrounding the Global Methane Forum in Toronto, Canada. The award, given by the Center for Clean Air Policy, Clean Air Task Force, Environmental Defence Canada, Environmental Defense Fund, and the Pembina Institute, recognizes Flir for its leadership and innovation in the creation of gas detecting cameras that are used in the Oil and Gas industry to identify and stop fugitive gas emissions.

The Flir GF320 and GFx320 allow oil and gas field personnel to visualize and geotag fugitive methane emissions in a manner that is compliant with the US EPA's OOOOa methane rule. Using these cameras, Flir has enabled oil and gas industry clients around the world to survey oil and gas facilities up to nine times faster than with traditional methods. In doing so, Flir's technology has helped these companies reduce their impact on the environment and made a positive impact on their bottom line.

www.flir.com

A Win at the German Innovation Awards

Developed by Macio for Yxlon International, the user interface for their new generation of industrial computer tomography systems has been chosen as the winner at the renowned German Innovation Awards 2018. The coveted German Innovation Awards showcase innovative products and projects, as well as their manufacturers and designers, in two competition classes: "Excellence in Business to Consumer" and "Excellence in Business to Business". In the "Excellence in Business to Business" category, Macio and Yxlon can be delighted with their successful joint project. Against 450 submissions, it prevailed as the winning project, selected by a top-level jury under the criteria quality of innovation, user benefit, and economy.

"Geminy" belongs to the high-resolution CT system, Yxlon FF 20/35 CT, and is now also being successfully installed on the brand new Yxlon FF85 CT inspection system. Developed by Macio according to the requirements of Yxlon, the software enables intuitive control of these CT systems via Smart Touch operation. Logical division across two monitors simplifies the analytical processes and shortens the analyst's familiarisation time, so that it can be worked productively within a short period.

www.yxlon.com

EMVA Young Professional Award 2018

The EMVA Young Professional Award 2018 went to Doris Antensteiner for her work "Light Field and Photometric Stereo". Antensteiner, age 32, obtained a master degree in Computer Science in 2011 and a master degree in Computer Science Management in 2014, both from Vienna University of Technology. Between 2012 and 2015 she worked as "Image Processing Engineer" in "R&D Video and Sensors" at Kapsch TrafficCom. Currently, she works at the Austrian Institute of Technology Center for Vision, Automation and Control and is a PhD Candidate at Graz University of Technology.

The awarded work resolves the problematic nature of acquiring a highly precise 3D surface reconstruction of objects with a focus on industrial applications. This is achieved by analyzing light rays passing through the camera lens, which capture a scene illuminated from a defined direction. An optimal fusion of light field and photometric stereo is found using variational methods. Solutions both for area-scan and multi-line scan cameras are achieved. The latter allows the algorithms in the awarded work to be apt for a wide range of industrial applications.

The 17th EMVA Business Conference will take place from 16 to 18 May 2019 in Copenhagen/Denmark.

www.emva.org

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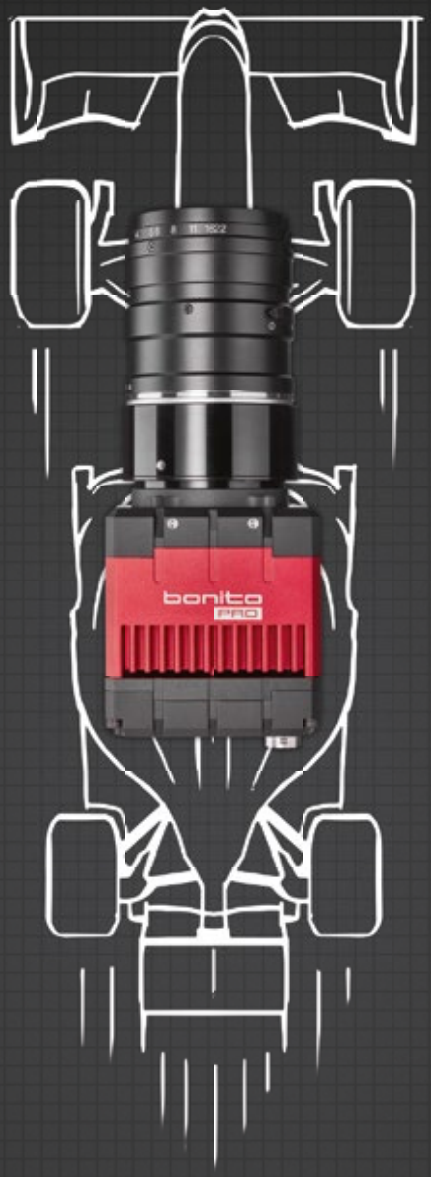

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