VOLUME 11
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VISION ‣ AUTOMATION ‣ CONTROL

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Vision(s) of the Future

Top-Line growth despite the recession could be registered during this past year in the so-called non-manufacturing applications of image processing and machine vision. A presentation of the first results – still preliminary – of the annual market study conducted by the EMVA, given by Director of Market Research Andreas Breyer at the business conference of the association in Istanbul this past April, has shown a respectable increase from about 12% to about 19% of total sales of European machine vision by these sectors in 2009. This number, a fifth of the industry's sales result after all, is even more remarkable considering that the market data is gained predominantly in the area of "industrial" machine vision. Companies being active mainly in areas such as life science, security, surveillance, document management as well as ITS, logistics and military, are not even covered by the EMVA survey. This is based in the historical roots of the association. Both, the European association EMVA as well as the German VDMA sub-group "Industrielle Bildverarbeitung" (Industrial Vision/Machine Vision) have their roots in the "traditional" markets of factory floor quality control automation that started about 20 years ago. These "seeing machines" are today an integral part of modern production technology. Even more: the major part of automated processes for the manufacturing of all kind of products – from toothbrushes up to complete automobiles – would not even be feasible without the vision technologies. The golden days of annual strong double-digit growth, however, have come to an end. The American industry association AIA has forecasted a very moderate growth of 3% for 2010; their European counterparts still expect an increase in turnover at about 11% for this year. Beyond the traditional feeding grounds of machine vision, however, the world moves at a whole different pace. Allow me to hazard the prediction, that we will see imaging technologies in every aspect of our daily life ten years from now. Small airborne robots will be used to automatically visually detect structural damages on buildings from above, guided by robot vision in the first place. Vehicle flow on the main traffic arteries will be steered by individual on-board cameras based on data from the higher-level traffic surveillance camera infrastructure. Our vacation planning will be done at 3D monitors within the augmented reality environment of the trip's destination having been fully digitized by 3D scanners. Miniaturized cameras regularly circle around inside our body and send out warning messages as soon as they detect something out of the order. Utopia? Maybe so. Maybe it will take ten years instead of twenty, but maybe this vision of the future is not yet even close to what will really evolve. Already today a vacuum cleaner that is guided through my place by vision can be obtained at Amazon for a mere € 300. My cell phone is able to identify my vis-à-vis by face recognition, find him in my address data base and spare me the embarrassment of having to reply to a joyful salutation at the trade show booth with a sheepish "sorry, what was your name again?"

So, is (industrial) machine vision out of style then? Of course, not. In our current "Visionaries" interview Norbert Stein points out that machine vision deployed directly inline in the production process instead of merely as an end-of-line tool is able to significantly contribute to preservation of resources, and thus to "Green Automation." Green Automation is by the way one of the core topics of this year's Automatica trade show in Munich. Robot vision, assembly control, 3D inspection, photovoltaic applications, thermal imaging, and much more from the successful present of machine vision can be found there – and of course in this issue of your INSPECT.

Enjoy reading!

Gabriele Jansen
Publishing Director INSPECT

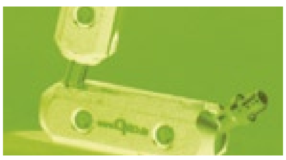
TOPICS

COVERSTORY

VISION

AUTOMATION

CONTROL



Calendar

DATE	TOPIC · INFO
25.–27.05.2010 Boston, MA, USA	**The Vision Show** North America's leading showcase of machine vision and imaging components and solutions www.machinevisiononline.org
08.–11.06.2010 Munich, Germany	**Automatica** International trade fair for automation and mechatronics automatica-munich.com
09.–11.06.2010 Yokohama, Japan	**ISS 2010** The image sensing show exhibits practical image processing products and technologies widely used www.adcom-media.co.jp/sensing/eng
15.–18.06.2010 Frankfurt, Germany	**Optatec** International trade fair for optical technologies, components, systems and manufacturing www.optatec-messe.de
12.–15.07.2010 Las Vegas, NV, USA	**IPCV '10** The 2010 international conference on image processing, computer vision, and pattern recognition www.worldacademyofscience.org/worldcomp10/ws/conferences/ipcv10
31.08.–02.09.2010 Dresden, Germany	**International X-ray CT Symposium** Symposium on high-resolution computer tomography www.phoenix-xray.com
13.–16.09.2010 Stuttgart, Germany	**Microsys** Trade fair for micro and nano-technology www.microsys-messe.de
27.–29.10.2010 Beijing, China	**Vision China 2010** China international machine vision exhibition and machine vision technology & application conference www.visionchinashow.net
09.–11.11.2010 Stuttgart, Germany	**Vision** International trade fair for machine vision www.vision-messe.de
09.–12.11.2010 Munich, Germany	**Electronica** International trade fair for components, systems, applications www.electronica.de
21.03.–24.03.2011 Chicago, IL, USA	**Automate** Automate is the new name for the International Robots, Vision & Motion Control Show sponsored by North America's leading trade associations for these technologies www.promatshow.com

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

Panasonic Founds Automation Solution Business Units

As of April 1, 2010, Panasonic Electric Works Europe AG, located in Holzkirchen near Munich, has established independent business units for Machine Vision and Laser Markers for the European market. This step is intended to lend even more substance to the company motto, „Panasonic Electric Works – your partner for competent industrial solutions." This development is also another example of the strategy to become a solution provider rather than merely a system supplier, primarily to better meet the needs of both, customers and partners. Both new automation solution business units will be part of the Technical Division at Panasonic Electric Works Europe AG and will be headed by Markus Fremmer (Machine Vision) and Reinhold Hiller (Laser Markers), respectively.

www.panasonic-electric-works.de

New Patents on High Performance Stereo Vision Systems

TYZX announced the issuance of two patents covering claims about performance optimization and data quality for stereo vision systems and stereo vision applications. The first patent, U.S. patent 7,576,702, entitled "Data Processing System and Method," covers claims for the use of parallel stereo vision for guiding robots and other unmanned systems. The patent also includes claims covering the use of data integrity checks during parallel stereo correlation and claims covering how applications can use stereo correlation results. The second patent, U.S. patent 7,664,315, entitled "Integrated Image Processor," includes claims that address the integration of additional functional units with stereo correlation to improve performance with greater parallelism and efficiency. These functional units implement vision tasks such as 3D data projection and background modeling in real time, eliminating latency and processing burden for applications such as person-tracking and robot guidance. Stereo correlation is the primary technology used across the vision industry for collecting 3D data without the use of lasers. TYZX has now received twelve patents for its stereo vision technology. "TYZX continues to invest in the research and development of high-performance, highly efficient stereo vision," said Ron Buck, CEO of TYZX.

www.tyzx.com

uEye Number 100,000

IDS Imaging hits a new milestone. Nearly six years after shipping the first uEye camera, the camera producer is proud to announce that unit number 100,000 has been delivered. On Wednesday, April 14, 2010, general manager Torsten Wiesinger handed over the uEye UI-5480-M, 5 Megapixel GigE camera to Ulrich Bäumler, manager of Industrial Image Processing at Bosch Stuttgart. To celebrate this special occasion, the camera was delivered in a golden housing and represents the spirit of the IDS camera philosophy: "Your imagination is our challenge."

www.ids-imaging.de

Non-industrial Applications Taking Off

The range of applications of machine vision systems, which have primarily been used to date in industry, is continuing to grow at an enormous rate in the non-industrial sector. This trend will also be reflected at Vision 2010, which will be staged at the New Stuttgart Trade Fair Centre from November 9 to 11, 2010. With the new subtitle "International Trade Fair for Machine Vision," Messe Stuttgart is indicating that the concept of Vision takes full account of the increase in the number of user industries. According to the German Engineering Federation (VDMA), non-industrial applications now account for more than 10% of the turnover of German machine vision companies and therefore occupy fourth place in the user industry league table which is currently topped by the automotive industry, followed by the glass and electronics industries. As the world's leading platform for machine vision technologies, Vision 2010 will have a total exhibition area of 20,000 m^2 in Halls 4 and 6 at the New Stuttgart Trade Fair Centre. The trade fair will present the latest components, complete systems and innovative solutions, including smart cameras, area scan cameras, line scan cameras, high-speed cameras, infrared cameras, vision sensors, frame grabbers, illumination systems, lasers, optics/lenses, optical filters, accessories, software libraries, application-specific machine vision systems, configurable machine vision systems, and solutions and services. The varied accompanying program will feature exciting trends and detailed information relating to industrial and non-industrial machine vision. The VDMA Machine Vision Group, the promotional supporter of Vision 2010, will also ensure that the trade fair is a success together with the European Machine Vision Association (EMVA) and the Automated Imaging Association (AIA).

www.messe-stuttgart.de/vision/

European Inventor Award 2010

Engineers Albert Markendorf and Raimund Loser from Leica Geosystems in Unterentfelden/Switzerland are awarded with Europe's highest distinction for inventors. The European Patent Office honors the portable metrology specialists for outstanding technical innovations in the "Industry" category. They are awarded for portable measuring devices which considerably facilitate the inspection of industrial components. This results in an overall sustainable improvement of the end products such as cars or planes. "We are very proud of this award and of the Leica Geosystems team that made this technical progress possible," said Raimund Loser. Alber Markendorf added: "It is an honor that the jury has chosen us among plenty of fascinating inventions. We are looking forward to advancing laser tracker technology even further in the future." It was in the middle of the 1990s when Leica Geosystems first identified a great need for mobile devices in industrial metrology. Albert Markendorf and Raimund Loser pushed the development of portable CMMs. Leica Geosystems, part of Hexagon Metrology, brought them to market successfully.

www.leica-geosytems.com/metrology, www.hexagonmetrology.com

Image S New MVTec Distributor in Italy

Image S, Italy's largest machine vision component distributor, decided to complete its product-portfolio by MVTec software to meet the requirements of a growing market for highly sophisticated machine vision standard software. According to Paolo Longoni, managing director of Image S, also in Italy the growing demand in 3D applications becomes more and more important, one of the main reasons for the decision to distribute MVTec software. "Italy is one of the most outstanding industrial markets in Europe," says Dr. Olaf Munkelt, MVTec's managing director. "Thus, MVTec wants to expand its sales activities in this important country. We are sure that Image S will meet our requirements in a distinguished way."

www.imagessrl.com,
www.mvtec.com

Jenoptik Joint Venture in Israel Receives First Volume Order

Jenoptik´s Optical Systems division and Dagesh F.K., Ltd. jointly announce that their joint venture Jenoptik OptiSys Ltd. has won a first volume order for assembly and test of medical imaging systems for preventive diagnostics from an international leader in ophthalmologic medical instrumentation after successfully completing shipment of a qualifying prototype series. The assembly and test work will be performed in the facility of Jenoptik OptiSys in northern Israel.

www.jenoptik.com/os

We´ve researched the Web for you and found this:

www.data.gov.uk

■ This website hosted by the British government follows up on the goal to make public data generated by governmental agencies easily accessible and easy to comprehend. HM is supported in this goal by renowned advisors like Sir Tim Berners-Lee, one of the fathers of the World Wide Web, and today Chairman of the World Wide Web Consortium (W3C). The site gives access to quite some useful information, e.g. you get to know that in 2008 a total of 557 producers of machines for food, beverage and tobacco generated a total sales of £ 1,047 million with about 9,000 employees. Numbers for staff cost, material cost and investments are given as well. This, of course, is only a very small glimpse into the type and level of information that can be obtained.

www.cuil.com

■ Cuil is a search engine sorting the results of a keyword inquiry right away into different content groups. When searching for "camera," e.g., the results are provided in the groups: digital camera, video camera, security camera and some others. For further separation, data is depicted, if possible and useful, in maps and timelines. In addition to the thus already presorted search results further data is presented in more categories. Again, when searching for "camera" one of these additional categories is "Electronic companies of Japan" with the companies Nikon, Sony, Minolta, Panasonic, and others listed. In a nutshell, Cuil is another attempt to pre-sort the no longer manageable amount of online search results in a smart way.

www.alltop.com

■ Alltop is a kind of "online magazine rack" on the web in that it compiles on an hourly basis the top stories from the most popular online magazines and blogs for a vast range of different topics. Here, questions like "What is up in China?" or "What is the latest on quality assurance?" might get answered. For this not the whole content available in the web is searched. Which data sources are actually used is decided by Alltop The tool offers a chance to stay up-to-date, within the given information sources, by setting up an individual mix of topics and making use of RSS feeds, and without the need to actively screen each one of all the individual sites.

http://network.inspect-online.com

■ The INSPECT network offers groups for users interested in specific topics. One of the new groups is focused on trade shows and events. Short reports of trade shows visited as well as announcements of interesting future events are posted here by members for members.

Feel free to send us your online favorites to contact@inspect-online.com

Seeing Machines

Automatica from June, 8 until June, 11, 2010, in Munich, Germany

From June, 8 until June, 11, 2010, Automatica, international trade fair for automation and mechatronics, takes place at the New Munich Trade Fair Centre. The trade fair's goal is to present the entire value-added chain in robotics and automation. Thus, the latest technologies from all relevant core areas of automation are presented. This includes machine vision, a field which is required for many tasks, more recently also including seeing in three dimensions. Dr. Olaf Munkelt, Chairman of the Board of VDMA Machine Vision, believes that 3D vision is at the beginning of an extremely fast development and forecasts that machines and machine vision technologies will be merging in times to come. The exhibitors of machine vision will present their products and novelties in halls A2 and B2.
In addition to visiting the general areas of the trade show, visitors also have the possibility to participate in special exhibitions and congresses. This year again, the service robotics innovation platform takes place, organized jointly by the trade fair and the Fraunhofer IPA. There, visitors can inform themselves about new products, prototypes and components in the field of service robotics. Among other innovations a mobile rope robot will be presented which could be of great help in setting up large-scale solar plants in the desert. Visitors searching for good ideas to put into practice will find them in hall B1: Successful practical examples, technological innovations and future trends will be discussed during the lecture and discussion forum "Automation in Dialogue".
Furthermore, Messe München organizes together with Vision Academy a series of technology seminars, which are offered free-of-charge for the trade show visitors. At the "Machine Vision Know How Lounge" in hall B1, five lectures per day will be held between 11 a.m. and 4 p.m. on June, 9 and 10, at a length of 45 minutes each. The lectures cover thematically the fields of vision sensors, smart cameras, 3D vision, machine vision software and thermal imaging. As speakers, the organizers could win experts which are able to provide information on the technologies' applications, application branches as well as on solvable tasks and their constraints from the viewpoint of practice. Explanations for functions, the state-of-the-art and a view on future developments and trends are planned to round off the seminars.

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Big in Japan

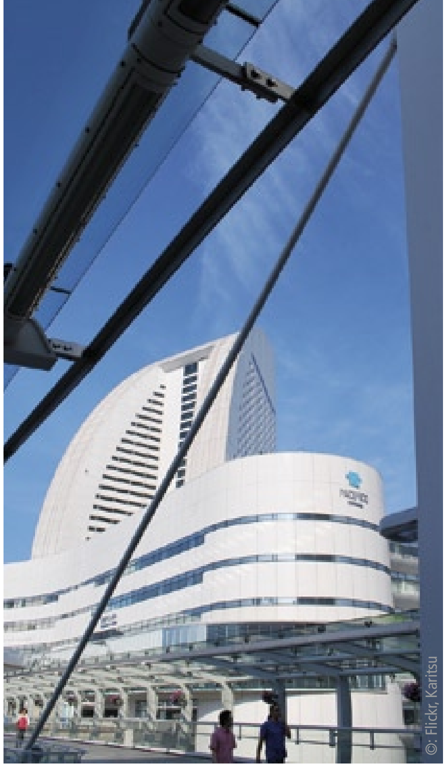
ISS 2010: Image Sensing Show in Yokohama, Japan

The Image Sensing Show, the Japanese machine vision exhibition, takes place in Yokohama, Japan's second largest city, from June, 9 until June, 11, 2010. For the 25th time, the exhibitors show their products in the fields of image processing, quality assurance and metrology at the Pacifico Yokohama fairground. Systems and vision sensors for inspection tasks and dimensional checks at the production site will be shown as well as products used in the fields of automotive, security, medicine, ITS (Intelligent Traffic Systems) or even sports and entertainment.

At the same time, the Image Sensing Technology Association organizes the nationwide largest symposium on imaging processing, the "16th Symposium on Sensing via Image Information: SSII 2010" joined by over 1,000 participants annually. The symposium has been highly acclaimed for getting the delegates into contact with the up-to-date technologies designed for practical use.

New in this year's exhibition program are dedicated platforms for system integrators as well as for metrology technology providers. In the first area concrete machine vision applications will be presented to the end-user and in-depth communication between user and manufacturer will be facilitated. The measurement platform concentrates on applications which go beyond the pure machine vision solution.

Like last year, the more than 150 trade show exhibitors expect about 20,000 visitors during the three days of the show. The fair's admission is for free, a registration in advance is not necessary.



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10th Optatec in Frankfurt, Germany

International Trade Fair for Optical Technologies Components and Systems

The Optatec is considered an industry meeting point with worldwide importance. The event takes place from June, 15 until June, 18 in hall 3 of Frankfurt's exhibition center and shows technologies, products, systems and services in the field of industrial optics. The trade fair for future optical technologies, components, systems and manufacturing is held biennial: a long term for such a rapidly advancing technology. On the one hand, this underlines its central importance in the optics, energy and medical industry; on the other hand the fair's organizer P.E. Schall makes sure to integrate every two years the latest developments in this industry. The focuses of this year's Optatec are trend topics including fibre-optics, photovoltaic, safety technology, LED illumination, and medical technology.

New additions this year are the theme park "Education and Research," the Analysts' Conference and the CEO Round Table initiated and organized by Spectaris.

The 10th Optatec provides a further value by the integration of the "EOS Symposium on Trends in Optical Technologies" which takes place simultaneously to the trade show. This symposium held by the EOS, the European Optical Society, focuses on knowledge and latest applications of optical technologies in the fields of photovoltaic, faser optics, LEDs, safety and medical technologies as well as standardization. In lectures of 90 and 120 minutes length, experts report on the newest trends and developments for the application of optical technologies. In order to fit in the tight time schedules of exhibitors and visitors the symposium's lectures can be booked separately.

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www.automatica-munich.com

Battling Windmills?

High-performance Platform for Computation-intensive Machine Vision Applications

In all industries camera resolutions and camera data transfer speeds are increasing, since ever finer structures and details have to be inspected in ever shorter cycle times. Thereby enormous amounts of data accumulate which have to be captured and processed. But, can the PC-system even guarantee the necessary bandwidth between all the expansion boards?

In Cervantes's novel of the same name, Don Quijote battles windmills which appear to him as giants. Gigantic are also the data streams which are generated by many machine vision applications. Consequently, camera resolutions and camera speed are constantly increasing. There is no end in sight. Line scan cameras with up to 12,288 pixels/line are used today as well as area scan cameras with 16 megapixels or even multi-camera systems. However, applications required to manage highest volumes of data are not restricted to machine vision applications only. Also computer tomographs, hyper spectral imaging and the 3D reconstruction and processing generate huge amounts of image data, which moreover often need to be processed in real-time.

Acquisition and processing of such big data streams does raise quite some issues for current systems: How and where to get the necessary performance? How are all the acquisition and hardware acceleration boards integrated? Is the PC-system able to guarantee the necessary bandwidth between all the expansion boards?

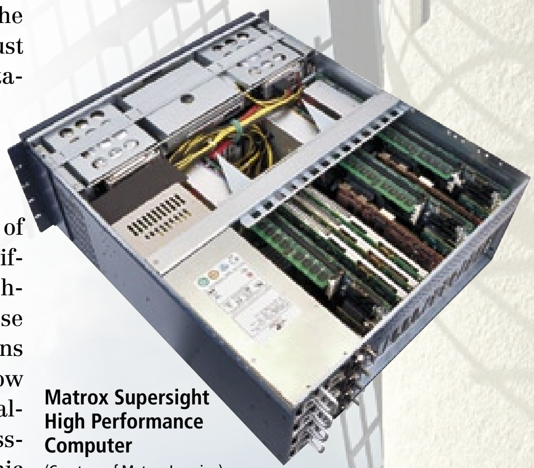
Matrox faces up to the battle against the windmills and presents Supersight, a flexible PC platform with high performance and nearly infinite expansion possibilities. Supersight is a true high performance computer (HPC) platform for highest performance and bandwidth.

Umpteen Slots

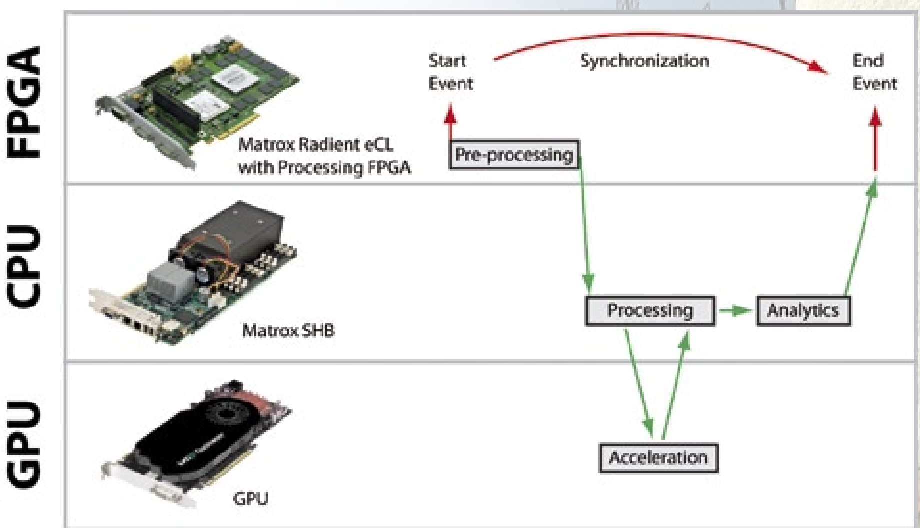
Supersight´s core component is the Matrox designed and manufactured PCI-Express (PCIe) 2.0 backplane. It offers four PCIMG 1.3 slots for CPU boards, the Matrox System Host Boards (SHB), and ten additional PCIe x16 2.0 slots for expansion boards like frame grabbers, VGA boards for GPU processing or any other acceleration and expansion boards. The thermal management inside the robust 19" 4HE rackmount enclosure allows stable operation of up to 14 active cards.

Concentrated Processing Power

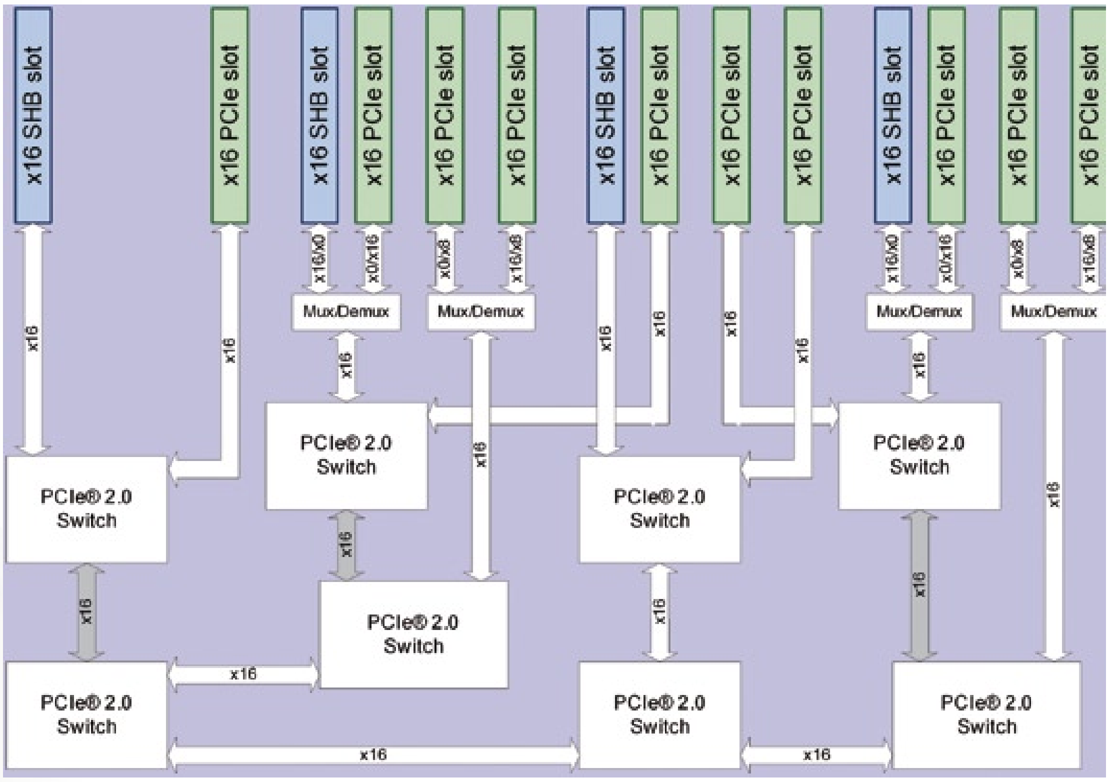
In order to provide a maximum of processing performance Matrox uses different, complementary processing technologies in parallel. General purpose CPUs are ideal for complex calculations and analysis of image data. FPGAs show great strength in pipeline and parallelized processes like image preprocessing through shading correction, dynamic thresholding or transformations. VGA



Matrox Supersight High Performance Computer
(Courtesy of Matrox Imaging)



Different processing technologies working hand in hand: FPGA, CPU, GPU (Courtesy of Matrox Imaging)



PCIe structured matrix guarantees high bandwidth
(Courtesy of Matrox Imaging)

boards are getting more and more common in imaging, since their GPUs offer significant processing power at very low cost.

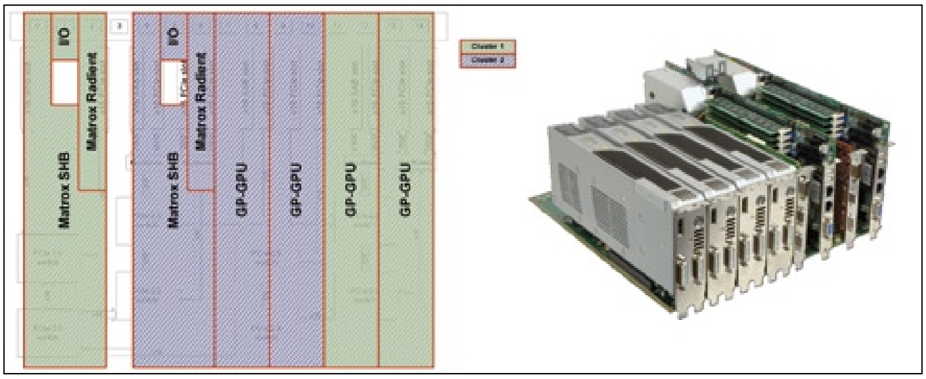
Matrox Supersight allows using frame grabbers for all kinds of image sources – analog, digital, Camera Link, DVI, and HD-SDI. Already during acquisition image data can be pre-processed e.g. with a Matrox Radient High-End grabber with Altera Stratix III FPGA or with Matrox Odyssey Vision processor boards, that use PowerPC CPUs, FPGAs and a pixel accelerator ASICs.

The Matrox System Host Boards with latest generation Intel processors are supported by 64 bit Windows and integrate two Nehalem quad-core CPUs, up to 48 GB of RAM and connectivity for Dual-GigE, USB 2.0 and VGA. Additional processing is done through additional PCIe x16 VGA boards from Nvidia or ATI.

A fully equipped Supersight features up to 8 Intel CPUs with 32 cores, 192 GB RAM and any combination of up to 10 additional VGA boards, FPGA frame grabbers and vision processor boards.

Maximum Bandwidth

By just adding many processing units a massive processing power will never be achieved. Pure processing power is nothing, if data does not get transferred to the specific processing units in time. So all Supersight PCIe slots are connected through an architecture of cascaded PCIe switches, forming a PCIe switched fabric. The switched fabric groups processing elements (CPUs, GPUs and FPGAs) into compute clusters. Data inside such a cluster gets copied with a bi-directional speed of up to 8 GB/sec (PCIe x16 2.0) from board to board.



A sample configuration: two clusters with 1x CPU, 1x FPGA und 2x GPU each (Courtesy of Matrox Imaging)

The architecture of Supersight allows great flexibility on which boards to use inside each cluster. Any configuration of processor boards, GPUs and optional frame grabbers working jointly on all the data without interfering with each other on a common bus.

Since all the links between the separate clusters are based on PCIe x16, communication between the clusters is very fast, too. Unlike classical segmented backplanes, the Matrox Supersight backplane, through the Distributed MIL (DMIL) communication API, enables clusters to look like a unified system.

Perfect Platform

To the advantage of demanding and computing-intensive applications, Matrox Supersight brings together the latest processing technologies – multi-core CPUs, VGA boards and FPGAs – and the flexibility of the switched fabric PCIe backplane for highest bandwidth. The Supersight high performance computing platform is a perfect fit for demanding and data intensive applications.

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"I Have a Dream"

Automation Technology Opens up Bin Picking Solutions

It was the year 1963 when Dr. Martin Luther King, Jr. gave his famous speech in front of the Lincoln Memorial in Washington, D.C. It should take years, however, before his dream turned into reality. Also in industrial automation there are some dreams still waiting to become true. One of them, offering great potential for efficiency increase in production and material handling in many industries, is to find a general solution for automated "Bin Picking."

The Adept AnyFeeder provides an economical alternative to well- known conventional part- feeding techniques

© JavierPsiloybin, Flickr

Especially in difficult market situations, like the one we are experiencing since the beginning of the financial crisis, manufacturers of goods as well as the whole automation market are looking for new or additional possibilities to open up efficiency and cost reduction potentials by introducing process automation. This might be one of the reasons for the recently increased interest in the application of "Bin Picking". Now, AMC Hofmann has created a comprehensive market report on this topic. By interviewing both, suppliers and users in many different industries, the compilation of an extensive survey of the market was made possible. At the same time, the report advances a common understanding for the application by information and know how transfer. The market report "Bin Picking" provides an in-depth insight into customer requirements, technologies, products, turnkey solutions, and suppliers.

Bin Picking Myth

As early as in 1998 a machine building company presented at a trade fair a well working demonstrator under the header of "Bin Picking" that impressively demonstrated the issue with the use of this term: A six-axis robot was picking –without any difficulty whatsoever – a single white square cube out of a black matted box.

A couple of years later, a robot manufacturer showed another "Bin Picking" demonstrator with cylindrical metal pieces to be taken out of a so called Schaefer box. The robot took the box and shook it, as soon as no more parts were left that could be detected or have been within reach for the gripper.

Both demonstrators showed clearly, that Bin Picking applications can be successfully realized. What then, is the reason that this application is being glorified now for many years as one of the last remaining challenges of robot vision?

With the term "Bin Picking" most users associate the unloading of parts of random orientation out of a bin by gripping them part by part with a robot. Several scenarios can emerge which make it impossible to get all parts out of the box without additional tools or strategies:

- a part cannot be recognized (detected),
- a robot path to grip a part cannot be created (caused, e.g., by the bin itself presenting an obstacle for approaching the part),
- a part cannot be gripped, because the gripping point is obstructed,
- a part cannot be taken out of the box because it is jammed with other parts.

Successful "Bin Picking," without additional mechanics or part separation, requires all of these steps being successful: part detection, gripping, generation of the robot path, unloading. The two applications given as an example earlier on have been designed by the suppliers in a way that the critical elements have been largely eliminated. In most of the industrial applications this is not possible, unfortunately.

So, what is necessary to solve more industrial "Bin Picking" applications successfully?

Common Understanding

The common goal of users and suppliers is always a working, cost efficient solution with high reliability. To meet this goal it is necessary to develop a common understanding of the real application requirements, the technologies being used, and the potential challenges coming with the application and the respective options for solutions. The expectation that it is possible to simply mount a camera on top of a box and have it transfer the position coordinates of randomly orientated parts to a robot which then picks all parts without any additional tools, will never be met.

Thinking Solution

Talking application means thinking solution. There is no isolated view on robot, gripper or machine vision system. Each subsystem is capable of many things in general, but there needs to be a working solution consisting of all these subsystems cooperating. If the vision system detects a part, but the gripper cannot pick the part the application won´t work. And if there are parts left in the box that could be picked, but not being detected by the vision system, it will not work either. Deep understanding of the application and the subsystems used, enable integrators to come up with best solutions possible.

Successful Solutions

Since many years now manufacturers as well as solution providers found ways to automate several "Bin Picking" processes by changing the ground rules.

In the automotive industry, today bins with pins are used for press parts like doors and hoods that enable automation with standard equipment. Many processes have been automated by introducing specially designed bins making detection and gripping of parts easier. Sometimes a look

Dynamis AB, bin picking cell with SensActive technology

to the previous process step enabled a solution by introducing rules on how to place parts into the bins in the first place.

In 2002 the robot manufacturer Adept Technologies (www.adept.com) came up with its first Anyfeeder product, a solution that became a great success and standard for many industries and processes by separating parts before detection and gripping. In 2008 Sweden based company Dynamis AB (www.dynamis.se) successfully introduced SensActive, a standard module for part detection in "Bin Picking" processes.

Such smart solutions on the one hand, further developments of technology, price reductions of standard components and a much higher level of understanding on the customer site on the other hand help to match expectation with capabilities and allows the implementation of more and more "Bin Picking" applications.

Offering different concepts for the realization of a project, based on the same core components is another important improvement. For quite some years now systems for robot guidance applications, such as gluing or inline measurement, are set-up with fixed mounted detection units, robot mounted detection units or hybrid, based on application needs. The combination of detection technologies, for example classic 2D or 3D machine vision with laser scanning enables additional degrees of freedom. Further improvement in algorithms for analysis of point clouds, as offered for example by Spanish company Aqsense (www.aqsense.com), are about to bring the solution tool box to the next level.

Market Overview

It should not even be a question, if the "Bin Picking" application is solved already or can be solved in the future. There will hardly ever be one universal solution for all possible processes, parts and requirements. This is something that is not expected of any other robot vision application, by the way. Customers understand and accept that different parts and processes need different solutions or set-ups and customizing. The key for successful "Bin Picking" projects is the know how and experience of the solution provider, their capability to chose the right components and technologies and customize the solution. An overview about successfully implemented concepts, solution providers and products for this application can be found in the AMC report.

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Recently read:

Market Report on 3D-Metrology for German Automotive and Supplier Industries

The third edition of the Fraunhofer Vision study presents on some 90 pages and supported by about 30 graphs and tables a survey on use and distribution of 3D metrology in the production and design facilities of the German automotive and automotive supplier industries. The goal of this study is the differentiated examination of up-to-date optical 3D metrology in comparison to the more traditional tactile procedures. 5,000 selected users from all areas within the automotive value chain (metal and plastics processing, machine building/engineering, automotive supplier, automotive manufacturer) have been addressed with a questionnaire. 254 evaluable responses to the questionnaire have been used as basis for the study. By including the similar surveys of the years 1999 and 2003 it is aimed to also show long-term trends.

The study begins with an introduction of the user and the supplier market, respectively. Numbers are given for the turn-over the German machine vision suppliers could generate with 3D applications in 2008 (source: VDMA) as well as for the global market volume for 3D CMMs in 2003 (source: Carl Zeiss IMT). No number could be put on the current demand for 3D metrology within the German automotive and supplier industries.

The core of the study is the description of typical measurement requirements and measurement objects, information regarding the measurement procedures, insights into the user behavior, and possible (and asked for) improvements in hardware, software and service. This part of the publication mainly relates to the methods of traditional offline coordinate measurement. The rather different aspects of systems working inline, e.g. integrated into the production at production cycle times, are not separately stated. For the next edition of this long-term study a clear separation between both aspects would be desirable.

Rounding off the study are about 30 pages of 3D metrology and 3D vision supplier portraits, presented in a structured way. This list is not claimed to be exhaustive, since the survey did rely at this point on the voluntary input of the market participants.

The study is available in German language.

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Readers' Corner

EMVA 2010: European Machine

International Machine Vision on a

Once a year the European Machine Vision Association invites the industry to their international business conference. Each year another attractive European location is selected to host the event. This year the city of choice was Istanbul, designated by the European Union as European Capital of Culture. The 13 million people megalopolis is one of the most dynamic and attractive cities worldwide, looking back on 2,600 years of history and culture. However, the participants of the 2010 EMVA conference had only one goal in mind: "Let's get out of here!"

The onset of the 8th European Machine Vision Association Business Conference was on a very sunny note, though. The 150 participants met already on the eve of the conference on a roof terrace in the vibrating Beyoglu area of the city. The lively networking of the leading heads of the international machine vision industry was adequately framed by a spectacular view on the sunset over the Bosphorus. During the next one and a half days the conference delegates got to know a lot about the economic situation of Turkey in general and the business climate for machine vision specifically, and about the opportunities offered by this dynamically evolving country. Not only for export but also for research and development within the coun-

No clouds on the horizon yet: Aytul Ercil, Vistek Isra Vision, gives an introduction to Machine Vision in Turkey.

(Image: EMVA)

Every year highly appreciated by the conference participants is the opportunity to network and exchange ideas with peers on an international business level: Kasra Ravanbakhsh (Kasra Hooshmand Engineering), Korhan Yirmibesoglu and Marcel Krist (Photonfocus), Martin Wäny (Awaiba) and Hakan Sakman (CMOS Vision).

(Image: Kasra Ravanbaksh)

(Image: Andreas Schaarschmidt)

At the initiative of Horst Heinol-Heikkinen, Asentics, 34 European visionaries betook themselves to a 2,000 km bus journey from Istanbul, Turkey to Munich, Germany. Over small sandy roads far away from the main traffic arteries the entire first night was spend only for the 350 odd kilometers to the Bulgarian-Serbian border. One or the other of the travelers developed quite an uneasy feeling during that night. Will a whole industry be abducted, fleeced, decimated here? But in the end all went well: after a 35-hour ride with the somewhat outdated vehicle through Turkey, Bulgaria, Serbia, Hungary and Austria finally Munich, Bavaria was reached. In the summary of Andreas Schaarschmidt, SVS Vistek: "Through this long journey we decidedly elevated the new industry 'Vision-Bus-Standard.' I am sure that by this joint experience our network has become even stronger than it had been before."

(Image: Ernst Rauscher)

Who says that no flights leave to Germany? With a private plane no problem whatsoever. Take off at noon in Istanbul, refueling stop in Dubrovnik and touchdown in Nuremberg, Germany, in time for afternoon tea. At the happy landing (right to left): Ernst Rauscher (Rauscher), Dirk Käseberg (Mettler Toledo), Bernhard and Julia Mindermann (Mikrotron), Ina and Uwe Post, Ellen Schmitt and Jean-Pierre Heinrichs (all NET) and the pilots.

Vision Adventure

Journey across Europe

try. Presentations about technical trends and market data from Europe, North America and Japan rounded off the conference program. The closing highlight most certainly has been the session with Mark McGregor, trainer with the internationally renowned St. Gallen Business School, talking about "Leadership after the Crisis."

Rather cloudy it became then through the Eyjafjallajökull volcano eruption. The delegates were stuck in Istanbul. Only a couple of east-bound flights could actually leave as scheduled; all flights to Europe and most of the flights to North America had already been canceled when the conference was concluded. However, the managers and entrepreneurs of the vision industry are known to rather remain at the helm and took matters of their destiny into their own hands. Let us show you here on two pages some of the adventurous trails the machine vision leaders took through the heart of Europe: dedication and perseverance invested to be back in the company at no time. These are the right partners for any business: creative, solution oriented, fearless and resistant to pain.

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(Images: Penny Pretty und Colin Pearce)

A journey of epic dimensions was mastered by the islanders of the British Empire. After several futile attempts at the Istanbul airport and repeatedly canceled flights, Colin Pearce (Active Silicon) and Penny Pretty (Laurin Publishing) finally managed to get air transfer to Barcelona on the Monday after the conference. At first it seemed that no further progress was possible from the Spanish city since the only means of transportation left was the 'surrey with the fringe on top.' Thanks to Penny's outstanding language skills and Colin's drive and steadfast optimism, however, on Wednesday morning the travelers could proceed by rental car via the Massif Central in Southern France to Le Havre up north. After three hours crossing the British Channel 'Good Old Blighty' was finally reached in the wee hours of Friday morning. The happy ending of this odyssey must have taken a load off Father-to-be Colin's mind.

(Image: Peter Ebert)

Quite a few of the conference delegates have chosen some variety of the plane-rental car combination for their travel. Junya Inada, Ralf Lattuch (both Omron), Peter Ebert (GIT Publishers) and – not shown – Marcus Bleise (Matrix Vision) first made it from Istanbul to Athens and then onward to Rome. Traveling by air came to an end there and after an overnight stay in the Eternal City the trip continued by car via Milan and the Alps. Ernst Luethe (Siemens) has even seen the Albanian airport of Tirana in a similar passage. Mark McGregor got lucky and hitchhiked a ride with Ignazio Piacentini (ImagingLab).

Some of the conference participants were stranded for up to one week in Istanbul. Not knowing if and when the path is clear to get back home greatly reduces the fun of alleged extended sightseeing. Networking, however, gets into a whole new dimension: (left to right) Christopher Hiatt, Andreas Breyer (EMVA), Henrik Ilsby (JAI), Arwyn Roberts (Grade Two), Jens Michael Carstensen (Videometer), Oliver Barz (Edmund Optics), Kirsten Braun (EMVA), Ingrid and Mike Cyros (AVT), Hans Steenberg and partner (Image House), Patrick Schwarzkopf (EMVA).

(Image: Oliver Barz)

(Source: Ingo Lewerendt)

What luck! For some a phone call came out of the blue: "How fast can you be at the airport?" Never before have suitcases been packed so haphazardly, shaves been finished so quickly.

Image: Shigeki Masumura

Contour Tracking

Image Processing Basics: Contour-based Pattern Matching

Pattern Matching is a method to search for a given template or so-called model within an image. The procedure results in a similarity image with a score figure at every pixel. The higher the score, the higher will be the probability for a real match between the template and the image region in the vicinity of this individual pixel. There are some matching methods based upon the contours of objects rather than grey-level templates. These algorithms process edges in images and use quite abstract relations between geometric primitives to check geometric models of objects.

Contours

The contour is the perimeter of a binary object. To use this concept, objects must have been successfully segmented from the background. Figure 1 shows an example with segmentation by simple thresholding. Labeling results in single binary objects, which are white in this example, and usually provides the contour on the fly, as shown in the right part of figure 1. Contour pixels are those object pixels which have neighbors in the object as well as in the background (or to be more precise, which have an object pixel in their 8-connected pixel neighborhood and a background pixel in their 4-connected pixel neighborhood). Based upon this criterion, these special object pixels can be separated and stored as the contour. A well-known and efficient method for coding the contour is the chain code. Beginning with a starting point on the contour the boundary of the object is traced from pixel to pixel and the corresponding direction is stored as an integer between 0 and 7. Figure 2 shows an example according to a common convention, Freeman's chain code. The starting point (x,y), depicted in red, is found by scanning the image from the left and from the top and is thus determined unambiguously. The contour completely determines the binary object, since the pixel pattern may be reconstructed from the boundary by filling, and thus must contain all the information which might be extracted from the 2D-object. As a consequence, there should exist methods to recognize an object based solely upon the characteristics of its contour. Let us have a look at an ideal square with edges parallel to the axes of the coordinate system. The starting point (x,y) will be the upper left corner. The contour is traced counter-clockwise, resulting in the direction 6 for the first edge, 0 for the second edge, 2 for the third and finally 4 for the last edge. Freeman's code for this square will thus consist of, depending upon the edge length, 20 directions with code 6, e.g., followed by 20 directions with code 0 and so on. Four groups of identical directions with equal length, each followed by a counterclockwise turn by 90°, will thus code a square. A turn by 90° corresponds to adding +2 (modulo 8) to the actual Freeman-direction and can be easily detected with an algorithm. Even an ideal square, however, will not show just four uniform directions after a real image acquisition, especially when the rotational position may be at random, but after smoothing the chain code, straight line segments with corresponding directional changes at their end points may be inferred. This simple example already shows the basic idea of contour-based pattern matching. Processing of the contour results in a geometric model of the object, which is de-

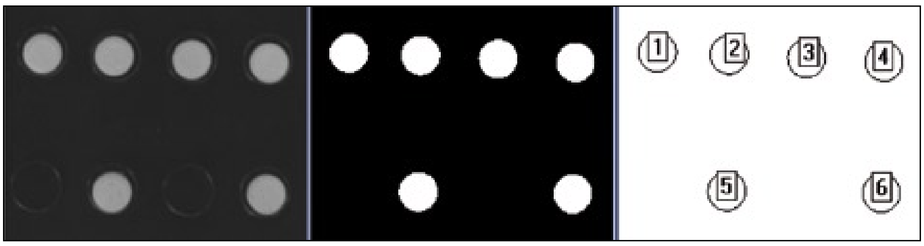

Fig 1: Grey-level image, binary image and label image with contours of binary objects.

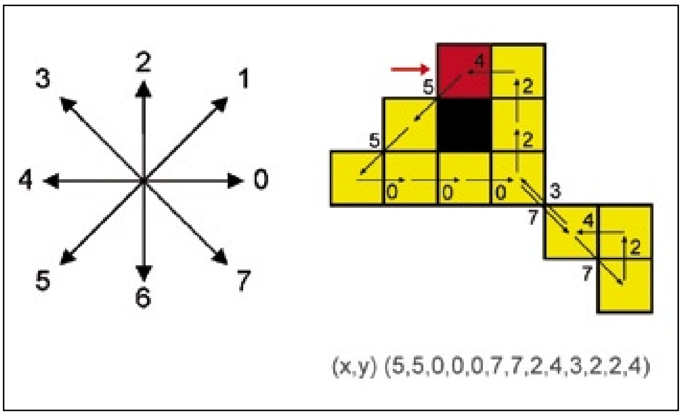

Fig. 2: Freeman's chain-code (left) and an example for chain-coding (right). The contour is traced counter-clockwise, beginning with the red starting point (x,y), and the direction of the subsequent contour step is stored.

scribed in abstract terms rather than as a grey-level template. In this sense, we will look at a square, when the contour is made up of four straight line segments of equal length, which are connected at their ends with a counter-clockwise change of direction by 90°. It is immediately clear that this description will apply to a square whatever its dimensions and angular orientation will be. The model thus will a priori be invariant with respect to scaling and orientation, which is quite a nice feature.

Correlating the Contour

As suggested above, the smoothed chain code of a binary object may be directly compared to the chain code of the template. In order to be invariant against scaling, which means to find similar objects but with different dimensions, the method must use the chain code normalized to a standard length. When the angular orientation is not controlled, there usually will be different starting points for the chain code of the object and of the template, respectively. Matching will be much more complicated under such circumstances. In some applications, features may be calculated from the chain code such as a histogram of directions, e.g., but information will be lost by such procedures, and the classification will in general be ambiguous. An alternative is to code the contour as the radius function. To obtain this function, the centre of mass of the binary object is determined. Starting from a reference direction, the distance between the centre of mass and the contour is measured in defined angular steps and plotted as function of the polar angle. This radius or polar distance function is like a finger print of the object, sometimes also called the signature. An example is shown in figure 3. The red curve in the right upper part of the figure is the smoothed radius function for the pentagon-shaped object shown on the left side. To match this function with a template, the signature of the object under examination is compared with the radius function of the template by shifting the template step by step through the full range of sampling angles and calculating the correlation for every position. When the correlation is above a certain, empirically pre-determined threshold, we have a match. The object is found, and, as additional useful information, the rotational position can be determined, since the angle of best match is known. This method may be regarded as the application of classic pattern matching with grey-level templates to the contour, represented by the radius function, and thus may well be called contour-based pattern matching. Abstract properties of a geometric model, however, have not been used in this approach.

Geometric Model Finder

Pattern matching applied to the contour function requires binary objects, and successful segmentation and a continuous boundary line without gaps are prerequisites. The description of the template by means of an abstract geometric model, however, opens up the possibility to directly compare features of the model with structures within the grey-level image. For this purpose, the first step is to calculate an edge image from the grey-level file and, in the ideal case, to thin these edges to a width of one pixel. The contours of objects thus show up as edges. There also appear, however, edge structures which do not belong to objects but are due to shadows or stem from the surface texture of objects, and some contours are frayed out. The next step is to look for the geometric primitives in the edge image, which appear in the description of the template in terms of geometric modelling. For the case of the square mentioned above, the edge image will be scanned for straight lines. Well suited for this task is the Hough-transform, which calculates a score for straight lines and also for collinear straight line segments. The score can be used to discriminate random matches against the best candidates for true straight line segments in the image [1]. There also exists a Hough-transform for circles, which has already been treated within this series of articles [2]. Straight lines and circles usually are sufficient for the description of contours of real-world objects as a combination of polygons and circular segments. For the square treated as an example above the geometric model means that four straight line segments of equal length have to appear in the edge image, which are in contact at their ends and show a counter-clockwise directional shift of 90° to each other. When only three line segments of equal length are found and a fourth line segment which is shorter, but the requirements concerning directions are fulfilled and three connecting points appear at the ends of the lines, there is a good chance that there is a square in the image which has been partly occluded by another object or is just shadowed. Such a structure may not be classified as a square immediately, but might be a good candidate for a closer look at the image region. Several Geometric Model Finders use more or less complex versions of the Hough-transform for geometric primitives and utilize the relations between these structural elements in the framework of the geometric model for the template or are based on the generalized Hough-transform [3]. By means of these procedures objects can be found which show severe gaps in their contours or which are partly occluded by other objects. With increasing number of parameters in a geometric model, however, the complexity of the implementation will grow, and the processing time will usually soon break the limit of the available time slice, at least for industrial applications.

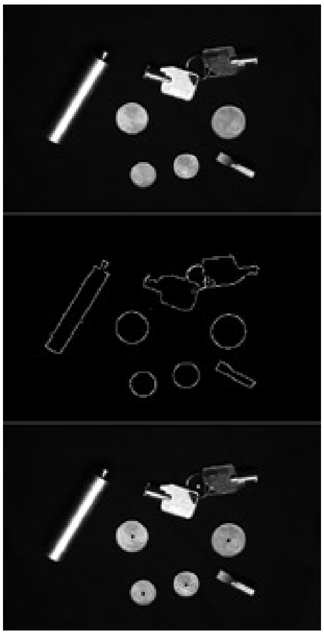

Fig. 4: Grey-level image (top), edge image (centre) and result of the Hough-transform for circles (bottom); points are depicted as overlay with the original image to show the centers of the circles detected. Mind the white point as centre of the partly occluded metal ring.

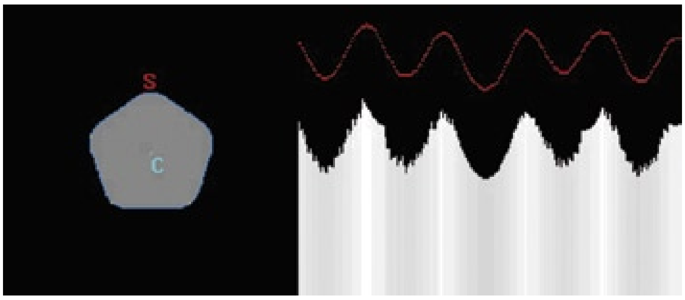

Fig. 3: An object and the corresponding radius function. C is the centre of mass of the object, S is the first contour pixel in the polar distance plot.

Conclusion

Contour-based pattern matching usually refers to search methods in grey-level images based on edge-images and using geometric models of objects. Such Geometric Model Finders may result in good performance even with partly occluded objects and can be invariant with respect to scaling and rotational position. Like the classic grey-level correlation, contour-based methods will only give a (sometimes quite small) probability for a match between the template and a structure in the image. There is a huge range of different approaches for construction and implementation of these procedures [4]. In figure 4, we used the Hough-transform for circles to demonstrate that even simple methods may already be robust with respect to reflections and inhomogeneous lighting, may show good discrimination against further structures and can be quite successful with partly occluded objects. Complex models may soon get out of control concerning processing time and must be carefully optimized [4]. There is no doubt, however, that Geometric Model Finders are a valuable additional tool in the image processing workshop and meanwhile belong to the basics of this field.

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Million-seller on the Advance into Machine Vision

USB 3.0: Promising in Market Penetration and Convincing in Technical Merits

The Universal Serial Bus (USB) is the most common serial peripheral interface in the history of computing. Present in virtually 100% of all computers, it is the standard for most computing peripherals and sells billions of units every year. To understand how USB 3.0 will impact vision in the future, it's important to first understand the road that led to its development.

The USB 1.0 specification was released by the USB Implementers Forum (USB-IF) in 1996 and ran at 1.5 Mbit/s (low-speed) and 12 Mbit/s (full speed). While useful for lower data rate peripherals, it was not until USB 2.0 (high-speed USB) was introduced in 2001 with a maximum raw data throughput of 480 Mbit/s (60 MByte/s) that the standard became useful for applications such as video and data storage, and led to the creation of the first USB 2.0 digital video cameras.

Improving Performance with USB 3.0

The USB 3.0 specification was released in 2008 with the goal of building on the strengths of USB 2.0 while addressing many of its limitations. The USB 3.0 specification increases raw data throughput to 5 Gbit/s (640 MByte/s). Though 8b10b encoding sets a practical limit of about 500 MByte/s, this still represents a substantial performance improvement over USB 2.0. USB 3.0 adds five wires for a total of nine wires in the connectors and cabling, and utilizes a unicast dual-simplex data interface. This allows data to flow in two directions at the same time; an improvement over USB 2.0's half-duplex unidirectional communication model. The USB 3.0 specification preserves the legacy bulk and isochronous data transfer mechanisms of USB 2.0. Bulk transfers are guaranteed delivery, but not bandwidth, while isochronous transfers provide deterministic communication with guaranteed bandwidth, making this mechanism well-suited to the transmission of real-time data. USB 3.0 significantly increases isochronous throughput from approximately 24 MByte/s to a total of 384 MByte/s.

Reduced System Overhead

The USB 3.0 architecture has many similarities to PCI Express (PCIe), and although there are obvious functional differences between them, they both aim to increase bandwidth and lower power consumption. USB 3.0 maintains much of the existing USB 2.0 device model, and like USB 2.0, is still a host-directed (aka master-slave) protocol. Every transaction either goes to or comes from the master, which is typically the host computer. One important change, however, is the signal-

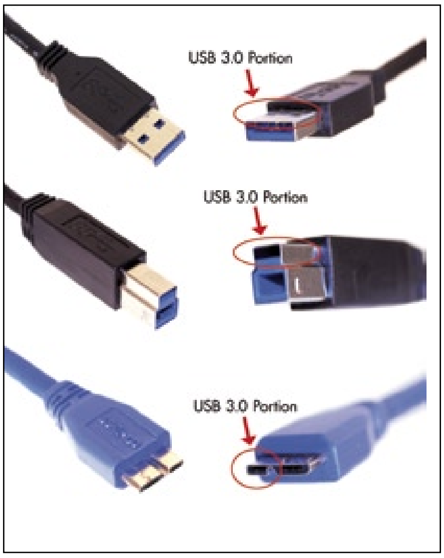

Fig. 1: Connector and cable-backward compatibility was a core design goal with USB 3.0

ing method. The USB 3.0 specification uses asynchronous signaling, which allows a device to notify the host when it is ready for data transfer. This significantly reduces system overhead and CPU usage compared to the polling mechanism in USB 2.0. A variety of other protocol improvements, such as streaming support for bulk transfers and a more efficient token/data/handshake sequence, are designed to improve system efficiency and reduce power consumption.

Fig. 3: Repeaters like Newnex's FireNEX-uLINK can extend USB 3.0 cable distance

Backward-compatibility Provided

In addition to an improved architecture and higher bandwidth, USB 3.0 also provides more efficient power management and increased power delivery over USB 2.0. The amount of current draw for USB 3.0 devices operating in SuperSpeed mode is now 900 mA, resulting in an increase in total power delivery from 2.5 W to 4.5 W (at 5 V). USB 3.0 also offers an improved mechanism for entering and exiting low-power states, depending on whether a device is active or not, and eliminates continuous power consuming polling. Although the USB 3.0 cable contains five new wires, it is still backward-compatible with USB 2.0, allowing consumers to continue to utilize their existing peripherals with a USB 3.0-enabled computer, or USB 3.0 devices with a legacy computer (see fig. 1). USB 3.0 Standard-A receptacles are backward-compatible with USB 2.0 but add new pins for USB 3.0 signals. The new Standard-B and Micro-AB receptacles are also backward-compatible (see fig. 1).

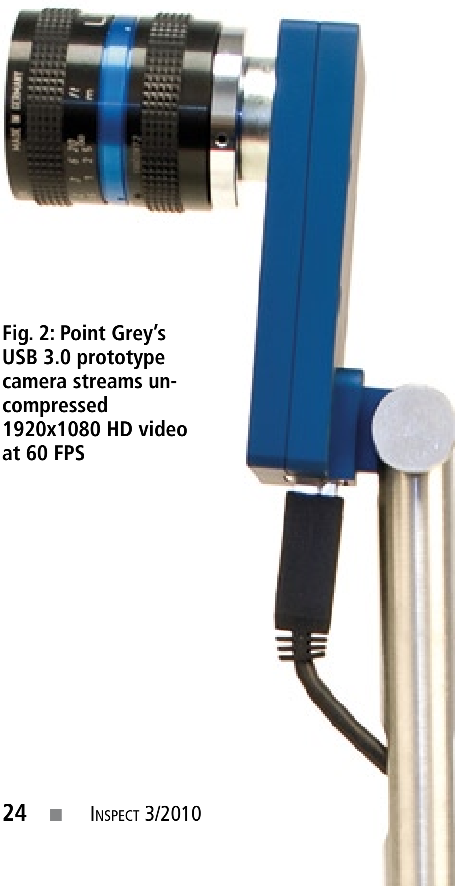

Fig. 2: Point Grey's USB 3.0 prototype camera streams uncompressed 1920x1080 HD video at 60 FPS

First USB 3.0 Cameras Presented

An abundance of USB 3.0 devices are already available, ranging from motherboards and hard drives, to interface cards and hubs. At the Consumer Electronics Showcase (CES) in January 2010, the USB-IF announced the first 17 consumer products that passed USB 3.0 compliance and certification testing. The silicon required to provide low-level connectivity for USB 3.0 devices is now available from companies like NEC, Fresco Logic, and Texas Instruments. This allowed Point Grey Research, Inc. to demonstrate the world's first USB 3.0 digital video camera at the 2009 Intel Developer Forum (IDF) in San Francisco (see fig. 2). The high-definition demo camera was shown streaming 120 MByte/s of raw, uncompressed 1080p60 video, generated by a high-performance Sony CMOS image sensor, to a Fresco Logic host controller. Other USB 3.0 products made their debut at CES 2010, including the FireNEXuLINK from Newnex Technology (see fig. 3), the world's first USB 3.0 active repeater capable of extending USB 3.0 signals up to 12 m in length.

Small Size and Low Cost

When compared to the existing lineup of digital interfaces, USB 3.0 has its strengths and limitations. The increased 500 MByte/s throughput and improved 4.5 W of power delivery is well-suited for many of the high-speed, multi-megapixel image sensors on the market today (see fig. 4). While Camera Link is still the bandwidth leader at approximately 680 MByte/s with a full eight-tap configuration, many customers may choose to sacrifice some pixels or frames per second in exchange for the easier to use and more cost-effective USB 3.0 alternative. Like FireWire, the USB 3.0 specification provides power and data over a single cable; has guaranteed, truly isochronous bandwidth; and is well-matched to applications requiring small size and low cost. However, while USB 3.0 is almost 10 times as fast as FireWire and GigE, FireWire provides more power (up to 45 W) and GigE's maximum cable length is superior.

Standard Protocols in Discussion

There are other practical factors to consider when evaluating USB 3.0 for vision applications. An important one is the control protocol implemented on the camera. FireWire and GigE cameras use the 1394-based Instrumentation and Industrial Digital Camera (IIDC) and GigE Vision standards, respectively, which enable compliant cameras to be used with any vision software package that also supports these standards. USB 2.0, on the other hand, has no such common protocol. The USB Video Class (UVC) is not appropriate for industrial digital cameras, leading some manufacturers to create their own proprietary camera control interface and others to use IIDC. The Automated Imaging Association (AIA), which historically has had no involvement in USB 2.0, announced at its January business conference a new USB 3.0 standard committee to evaluate appropriate protocols like IIDC and GenICam.

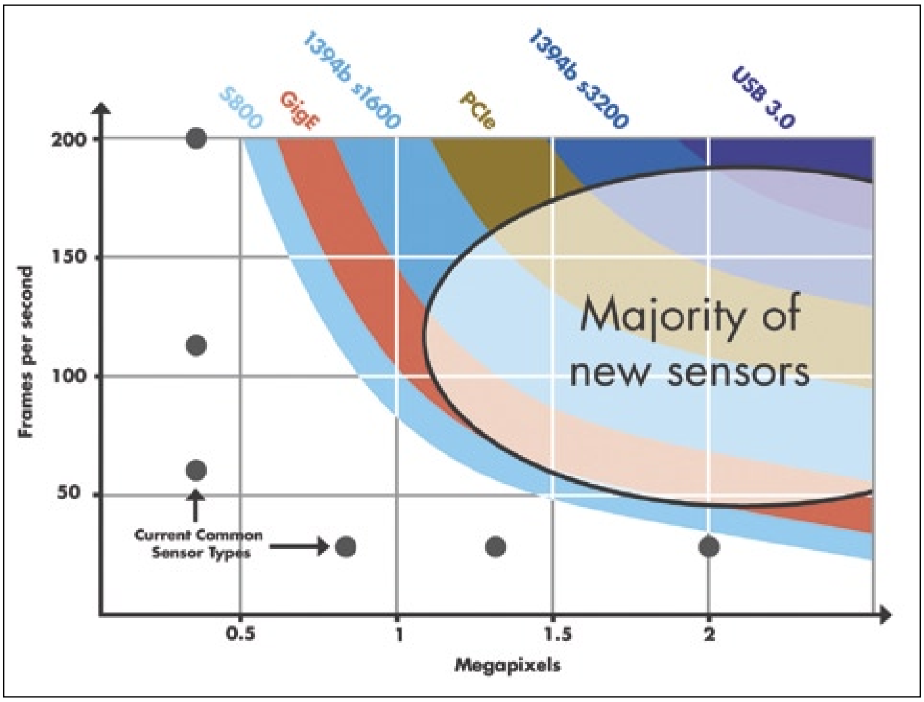

Fig. 4: Most existing digital interfaces do not provide the required bandwidth for many new image sensors

Long-distance Cabling in Development

Another consideration is cable length. The maximum length is not explicitly specified in the USB 3.0 standard. However, the standard does describe the relationship between wire gauge and maximum length in order to achieve USB 3.0 voltage drop requirements. For example, a cable can be up to 5.3 m long when using an American Stranded Wire Gauge (AWG) of 20. In the majority of cases, the host computer system is located within this distance. A variety of high-performance and cost-effective solutions will rapidly become available to address situations where longer distance is required. USB 3.0 hubs and repeaters already are in production, and work on signal-corrected long-distance cables, equalizer technology like EqcoLogic's EQCO5000, and long-haul optical solutions is in progress. Other USB 3.0 cable and connector products geared toward industrial and machine vision are under development, including screw-locking connectors, high-flex chain cables, and so on.

Technical Merits Boost USB 3.0

It is clear that consumer market acceptance of USB 3.0 will be ahead of the vision industry. However, USB 3.0 promises to open up new applications in machine and computer vision, as well as in non-industrial markets where USB 2.0 already has widespread acceptance. While there is no single digital interface that works best for all vision applications, on technical merits alone USB 3.0 will be a strong contender, and will certainly become an important camera interface in the years to come.

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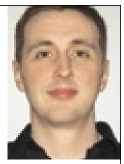

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Baptism by Fire for Vision System

Vision System Automates Fire Extinguisher Container Production

Not just the two basic types of extinguisher, i.e. powder and water, but up to 80 different extinguisher variants can be distinguished. At producer Minimax they are all filled and bolted at one single production line. For correct actuation of the screwing system, a vision system identifies the containers.

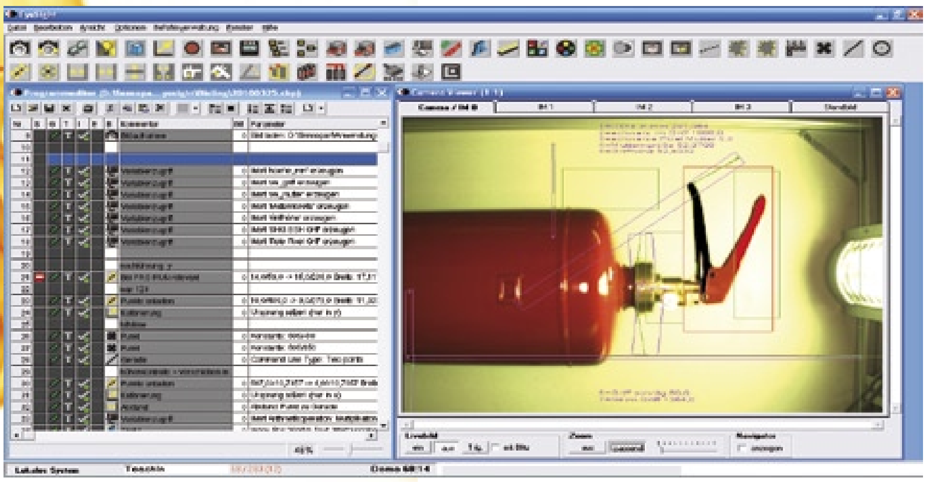
The Eyesight Advanced Vision System by SensoPart identifies fire extinguisher containers based on different geometry and colour characteristics. An LED ringlight ensures optimal illumination

Fire extinguishers can save lives and prohibit substantial material damage. Provided a fire at home, at the office or even in the car is detected early enough, even a layman can quench it with a fire extinguisher. It is mandatory, though, that a device is used that is suited for the respective type of fire. Consequently special care has to be applied in assembly and filling of these products.

The system integrator Bieling System- & Robotertechnik and the company Becker Fertigungstechnik have jointly designed and build a fully automated production facility for Minimax, a supplier of fire protection systems. Fire extinguisher containers of different dimensions are filled with powder or water, and subsequently screwed together. The Eyesight Advanced Vision System by SensoPart Industriesensorik recognizes the type of extinguisher based on different characteristics. This includes the height of the container, the diameter of the screw nut, and the contour and color of the handle. The system supplies the information as a serial protocol via the integrated RS 422 interface to the PLC; the latter then transmits the appropriate set of parameters (position and torque) to the screwing system. An FT 20 RLHD laser scanner, also developed by SensoPart, ensures a reliable final cut-off if the screwing system overshoots the target.

Intelligence Incorporated in the Camera

The Eyesight vision system consists of a compact FA 45 smart camera with integrated illumination, a 400 MHz signal processor, 100 Mbit Ethernet and RS 422 interfaces, and digital inputs and outputs. The system is completed by the high-performance Eyesight configuration software for creating a wide range of image processing applications. „The system is ideal for the assigned automation task," explains SensoPart application engineer Jan Huesmann. Eyesight determines the data for the container identification, and transmits this data to the PLC, which actuates the screwing system accordingly. „In principle, the vision system could also perform the evaluation of the measured data and provide the type number of the determined container, for example," adds Huesmann. „The intelligence required for this is incorporated in the camera." In the present usage scenario, however, up to 80 different containers have to be distinguished, so it was finally decided that



With its graphics-based programming, the Eyesight Vision System focuses on user-friendliness
(Photo: Bieling)

the PLC – as the“ data memory“ – should also carry out the evaluation.

Programming by Drag and Drop

Compared to a PC-based image processing solution, which would also have been an option in the present application, Eyesight is a very cost-effective and user-friendly system. „The Eyesight configuration software allows graphics-based programming by drag and drop. Even if the user is not an image processing expert, they will find it easy after just a little practice,“ says SensoPart engineer Huesmann. The customers (in this case, the system integrator Bieling System- & Robotertechnik) can thus create their applications themselves. At Minimax, the automation solution passed its test a long time ago: An initial fire extinguisher production line equipped with Eyesight has been in operation since the middle of 2009, and another identical installation is currently being planned.

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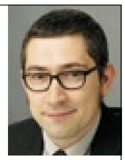
Marketing Manager



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Avatar Out of Bavaria?

3D Tools and Movie2 Are Two of the New CVB 10.2 Features

Stemmer Imaging has recently launched version 10.2 of their vision software library Common Vision Blox (CVB). We had the chance to talk with Peter Keppler, Sales Manager Systems Solutions at the Puchheim based imaging technology supplier, about the new features and highlights.

INSPECT: Mr. Keppler, since recently version 10.2 of Common Vision Blox is on the market. What changed, which new features can we look forward to?

P. Keppler: Since the first release back in 1997, our programming library Common Vision Blox has been continuously enhanced and adapted to ever new market requirements. Some interesting new features have now been introduced for Version 10.2. Highlights are the full support of all 32-Bit versions of Microsoft Windows 7 and the AIA certified CVB GenICam driver that is compatible with the latest GenICam V2.0 standard. In addition the new version incorporates new innovative tools for 3D applications, as well as an enhanced version of the successful sequence recording tool CVB Movie.

CVB 10.2 now supports 32-Bit versions of Windows 7. What are the plans for 64-Bit?

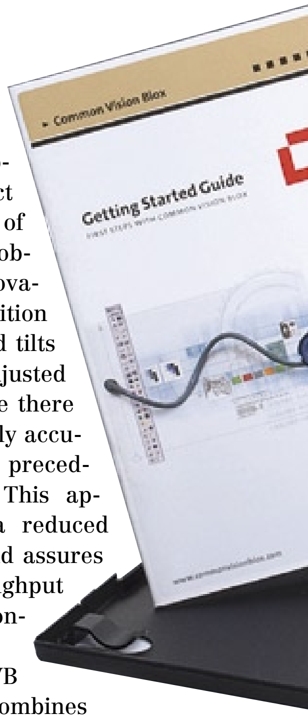
P. Keppler: Windows 7 has been tested extensively by our developers. This new operating system is extremely well suited for industrial imaging applications and we are sure that it will establish itself quickly. For the moment we have concentrated on the 32-Bit version as it has the largest base of supported hardware and our customers are thus able to transfer existing projects quickly. In addition it is an adequate replacement for the proven Windows XP operating system.

However, we are sure that especially the 64-Bit versions offer an interesting perspective for industrial imaging. Hardware of existing PC-systems is already laid out for it and many imaging algorithms can take advantage of the benefits a 64-Bit operating system offers.

Therefore our developers are working hard on a true 64-Bit version of Common Vision Blox. As a first step our popular independent GenICam-SDK, the CVB CameraSuite will be delivered shortly after in a full 64-Bit version with all GigE Vision cameras supplied by Stemmer Imaging.

For some time now CVB has offered the functionality for 3D machine vision. The new version now includes two new tools. What advantages do they offer for the user? Can these tools be used separately or only in combination? Which hardware is supported?

P. Keppler: Before starting our activities in the field of 3D imaging, we have carefully analysed which algorithms are really required in the industrial environment and which ones offer a real value add. The first tool, CVB Match 3D, was developed to enable comparisons of point clouds of different objects and to detect smallest deviations of complex free form objects. Based on innovative algorithms, position errors or tipping and tilts are automatically adjusted in all six axes. Hence there is no need for a highly accurate part positioning preceding the inspection. This approach results in a reduced mechanical effort and assures high inspection throughput for 100% inline control.



The new tool CVB Merge 3D now combines 2.5D images from multiple cameras to overcome the systematic deficiency of laser line triangulation and to make sure that all flaws and defects will be detected. Without this tool shadowing effects could lead to areas where no data is available and areas, so-called holes, might remain which cannot be inspected.

Based on frequent requests from the market we developed CVB Metric 3D. This tool enables a 3D space to be calibrated by measuring a defined calibration object. Once calibrated, data point area or volume can be directly measured to sub pixel accuracy. All those 3D tools can be combined with each other, or can be used in combination with other CVB 2D tools. However, it is always important to work out an individual solution for each application. As far as acquisition hardware is concerned, we recommend using triangulation cameras from Automation Technology. We deliver those fully tested with software, optics and lasers from one single source.

Let's get back once more to the 2D world: With Movie2 Common Vision Blox now incorporates a successor for a tool that has been well established for some years. What advantages does this new version offer for the user?

P. Keppler: Using the hardware independent image acquisition that CVB offers, special cameras and other imaging

3D technology from one source: CVB version 10.2 combined with AT triangulation cameras

sensors can be used. Many of those image sources deliver extremely high frame and data rates, which are used for documentation purposes. They are recorded as videos, archived and are later analysed. Using CVB Movie in combination with our optimized camera/computer combinations, many challenging sequence recording systems have been realized.

The new tool CVB Movie 2 now allows additional text meta data such as time stamps, GPS-positions or production data to be recorded into the AVI container. This data is not visible on the recorded image, but explicitly assigned to this individual image.

The library has also been extended by an optional user interface. This option offers comprehensive recording and processing functions without requiring the user to develop their own interface.

For the last year Stemmer Imaging has delivered all GigE cameras with an own SDK. What advantages does this offer for the user? Which cameras are currently delivered with the SDK? What future developments are planned in this area?

P. Keppler: From the very beginning, Stemmer Imaging has been a driving force in the definition of the standards GigE Vision and GenICam. Therefore we are able to offer a highly optimized driver based on CVB, which is not limited to any special camera or supplier.

In order to offer our customers the best possible driver, we include CVB CameraSuite free of charge with all GigE Vision cameras we supply. It delivers advanced image acquisition functionality and provides developers with a manufacturer independent GigE Vision API that also supports other acquisition technologies and the GenICam transport layer. Right now we deliver the 32-Bit version of this SDK. Versions for Windows 64-Bit and Linux 64-Bit are under development and will be available shortly.

Mr. Keppler, thank you very much for this interesting glimpse into the new CVB version.

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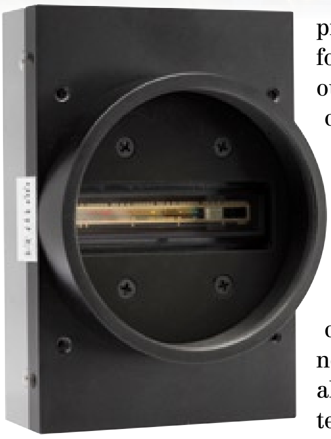
Madonna © canontiker/Flickr.com; Mount Fuji © skyseeker/Flickr.com

Powerful Combination

Line Scan Cameras with CMOS Sensors: Reduced System Noise and High Read-out Rates



The CMOS technology has significant advantages over the CCD technology which are transferable to line scan cameras. Due to on-chip processing, such as signal amplification and the A/D converter, analog signal transmission is no longer necessary and system noise is reduced. The CMOS technology allows for higher pixel frequencies and read-out rates using the same interfaces, and is an essential requirement for high-resolution image processing tasks in the solar and glass industry and in the coating industry. In order to cope with the constantly increasing production speeds required for web material, the read-out speed of the line scan camera is becoming an increasingly crucial factor. The level of light sensitivity provided by the latest CMOS generation is considerably higher, and easily compares with corresponding CCD technology. Taking into account all of these factors, CMOS technology provides the basis for an increase in image processing requirements without increasing the system prices.

The Japanese company NED (Nippon Electro-sensory Devices Corp) has over 35 years of experience in developing line scan cameras and systems. Since 2006 NED has been working on developing industry first CMOS line scan cameras, and has been able to come up with a high speed camera lineup from 1k to 8k resolutions with low noise levels. NED has now entered into a partnership with the German company NET (New Electronic Technology GmbH) in order to provide the CMOS line scan cameras also for the European machine vision industry.

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Series Production of GigE Cameras

Basler Vision Technologies has started series production of the first four models in the ace series of compact area scan cameras. The models include both mono and color versions of the high quality Sony ICX618 VGA and ICX445 1.3 MP CCD sensors, running at 100 frames per second and 30 frames per second respectively. The cameras are just 29 x 29 x 42 mm in size and offer features such as Power over Ethernet, opto-isolated digital inputs and outputs, a 60 MB on-board image buffer, and user sets for storing parameters. Basler's ace cameras are designed for intelligent traffic systems and for robotics, electronics, semiconductor, and medical applications. Series production start for further four ace models is planned for the next quarter.

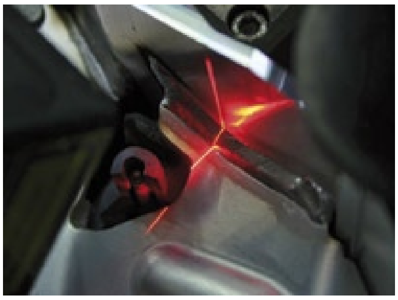
Basler Vision Technologies · Tel.: +49 4102 463 258 · info@baslerweb.com · www.baslerweb.com

HDR Camera with GigE Vision Interface

JAI announced the AD-081GE high dynamic range (HDR) camera, a new 2-CCD camera with a GigE Vision interface and a variety of advanced operating modes. The AD-081GE is a follow-up to the Camera Link model (AD-081CL) which was launched last year. The new camera features an innovative 2-CCD design with two stan-dard ICX204AL 1/3" monochrome progressive scan sensors mounted to a custom-designed optical prism. The prism-based design enables the camera to simultaneously capture two channels of 30 fps video, with each channel having 1,024 x 768 resolution, 8- or 10-bit pixel depth, and precise alignment to the same optical axis. Typical HDR applications for the AD-081GE include inspection tasks where incident light or bright reflections are present, such as LED inspection, welding, and various types of lighting or glass inspections.

JAI A/S · Tel.: +45 4457 8888 · camerasales.emea@jai.com · www.jai.com

New Sensor in a Slim Design



Vitronic presents the new generation of its welding seam inspection system ViroWsi which exhibits a completely reengineered sensor. A slim, compact design in combination with the latest technology guarantees the highest performance for inline inspections. The system objectively inspects the seam and sorts out defective parts. Due to combined 2D/3D image recording, even extremely flat seams can be reliably proofed. Highly reflective materials such as aluminum also are inspected with respect to flawless welding seams with the new sensor. All results are directly incorporated into a protocol and stored for subsequent tracking. The acquired data forms the basis for the process optimization, as well as for the manual and automatic reworking of the seam.

Vitronic Dr.-Ing. Stein Bildverarbeitungssysteme GmbH
Tel.: +49 611 7152 0 · sales@vitronic.de · www.vitronic.de

Compact Gigabit Ethernet Camera

Matrix Vision presents its newest member of the Gigabit Ethernet camera series: mvBlueCougar-X. The camera series will cover various applications with its wide range of highly sensitive CCD and CMOS color and gray scale sensors. C-Mount, CS-Mount as well as S-Mount lenses are supported. The mvBlueCougar-X has a 14 bit A/D converter and a high signal-to-noise ratio. With its 64 MB camera memory, it is possible to acquire images and image sequences and to uncouple transfer from acquisition. The camera offers hardware based preprocessing for small processing times and, furthermore, fast resend mechanisms and settable bandwidth limits which are perfect for multiple camera operation. Further innovative features are flat field correction, auto gain/shutter, Bayer demosaicing on the camera, as well as YUV and RGB color formats.

Matrix Vision GmbH · Tel.: +49 7191 9432 0 · info@matrix-vision.de · www.matrix-vision.de

Vision Sensor with External Touchscreen

Turck has introduced remote display versions to extend the capabilities of its iVu TG Image Sensor and iVu BCR Bar Code Reader. Designed by Turck's partner Banner Engineering for applications where the sensor must be placed in a difficult-to-reach location, the new units allow setup and inspection monitoring to be done at a remote control position. For example, the sensor could be located inside a machine or on an elevated conveyor, with the control unit placed outside for easy operator access. Applications for the new sensors are found in a wide range of industries, including automotive, packaging, material handling, pharmaceutical and electronics (PCB and assembly). With intuitive user interface and LCD touch-screen display, the sensors are easy to configure with no need for image processing expertise or an external PC.

Hans Turck GmbH & Co. KG
Tel.: +49 208 4952 0 · more@turck.com · www.turck.com

Cameras with Dual GigE Vision Technology

SVS-Vistek complements its camera line SVCam-HR with two new models, the svs8050 and the svs4050. The new HR models are equipped with two GigE interfaces so that the whole bandwidth of a 4-tap CCD-sensor can be used. The technology works in compliance with the convention of the Link Aggregation Group LAG. The cameras work with high-quality interline-CCD progressive-scan sensors from Kodak. The configuration software allows operating these cameras also in slower 1- or 2-tap mode with only one GigE-interface. The cameras are available as monochrome or colour version and suit best for applications which demand high camera resolutions and fast image transmission times. Areas of application for these cameras are e.g. print inspection, PCB inspection, solar-, wafer- and semiconductor industry as well as optical metrology.

SVS-Vistek GmbH · Tel.: +49 8152 9985 0 · sales@svs-vistek.com · www.svs-vistek.com

Camera Cable for the Drag Chain

The tailor-made cable manufacturer Ernst & Engbring presents a brand new camera cable: a flat Camera Link cable for a scanner-like QA station which performs a detailed high-speed quality check of fully assembled boards. Before, the imaging QA system for electronics needed 44 symmetrical data lines with 100 Ohm impedance for high data rates. E&E solved the task with 44 data lines which are systematically arranged to guarantee identical electrical specifications for all data pairs performing in the drag chain. The design resulted in a flexible flat cable with only 11 mm thickness. All wire pairs are individually shielded. The new abrasion-resistant clean room-style flat Camera Link cable withstands accelerations of up to 1 m/s and is rated for 25 million bending cycles in drag chain-operations.

Ernst & Engbring GmbH & Co. KG
Tel.: +49 2368 6901 0 · info@eue-kabel.de · www.eue-kabel.de

New MRC Coating for Industrial Filters

Schneider-Kreuznach's industrial infrared filters now have a new MRC-IR coating (Multi Resistant Coating). This new development offers superior antireflection in the non-visible wavelength range of light, i.e. the near infrared range from 620–1,100 nm. They are mainly used in machine vision applications, for monitoring traffic with night vision and other industrial and research uses in the infrared range. Schneider-Kreuznach almost always uses colored glass from Schott for its high-precision filters. Its scratch and water-resistant as well as dirt repelling outer coating makes the surface of the glass easier to clean and protects the lens, even in a coarse industrial environment. The minimum residual reflection (0.5%) means that MRC glass reliably eliminates ghost images or double images caused by camera sensors reflecting light.

Jos. Schneider Optische Werke GmbH · Tel.: +49 671 601 205
industrie@schneiderkreuznach.com · www.schneiderkreuznach.com

Pharmaceutical Track & Trace Solution

Cognex announced In-Sight Track & Trace, an add-on software package for Cognex In-Sight vision systems. It delivers a ready-to-deploy data capture and verification solution designed to help pharmaceutical and medical device manufacturers achieve unit-level product traceability. In-Sight Track & Trace combines Cognex code reading and verification software with a pre-configured job file and HMI interface that reduces setup time and makes it easy to exchange data with third party systems as needed for a full serialization solution. The software is easy to configure and operate using a touch screen interface. For a ready-to-deploy solution, In-Sight Track & Trace can also be controlled using the Cognex VisionView 700 Operator Interface panel or VisionView PC software.

Cognex Corporation · Tel.: +1 508 6503140 · info@cognex.com · www.cognex.com

3D and RGB Color Imaging in One Camera

Sick is introducing its high-speed 3D camera with high-quality color capability: the ColorRanger E. It is the newest member of Sick's 3D camera product line. They solve various inspection tasks by measuring shape, contrast, and surface defects, to ensure product quality and production reliability. The ColorRanger E expands the inspection possibilities further by also providing high-resolution RGB color at up to 3,072 pixels per channel. With simultaneous 3D and color information at more than 11 kHz, multiple inspections can be performed in parallel at full production speed. This is, for instance, common in grading fruits and vegetables, shape and baking degree verification of baked goods, quality assurance of electronic assemblies, and fill level and color verification in the pharmaceutical industries.

Sick AG · Tel.: +49 7681 202 0 · info@sick.de · www.sick.com

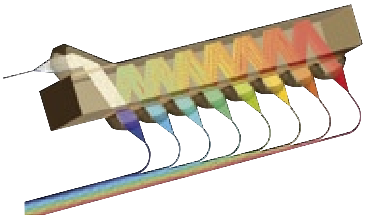
Multi-Processor Smart Camera

Starting from now, Dalsa provides a high resolution model of its BOA vision system, the model BOA M1280. The highly integrated smart camera comprises all of the elements of an industrial machine vision system. The camera offers high image quality at a resolution of 1,280 x 960 pixels and operates at up to 24 frames per second. The BOA is an all-in-one machine vision solution that is easier to use and more flexible than previous generations of smart cameras. It incorporates multiple processing engines. This enables algorithm optimization via DSP, application management via CPU, and sensor management via FPGA. It is also offers truly embedded application software, which is easily set-up through a standard web browser. A complementary color version of the high-resolution BOA vision system will be available later in the year.

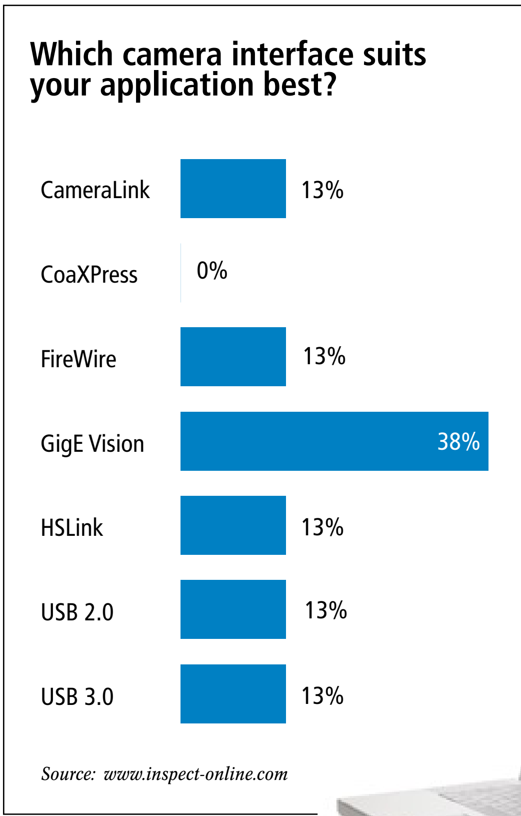
Dalsa · Tel.: +1 519 886 6000 · info@dalsa.com · www.dalsa.com

Raytracing Software for Simulation

In sequential and non-sequential mode, the tool Fred simulates the beam propagation of coherent (Gaussian-beam-propagation) and incoherent light. The extensive functions and the 3D-view make Fred an outstanding simulation tool for new inexperienced users as well as for experienced designers. The Raytracing-Software allows the optimization of optical elements depending on the target functions (merit functions). The simulation tool is compatible to step- and iges-files and helps to setup existing CAD models quickly in Fred. Additional to the new optimization function and the extensive capabilities Fred is now accelerating the simulation due to the support of not only the standard dual-core and quad-core processors. It was designed especially for the technologies of AMD Opteron, Intel Xeon, Itanium and Pentium IV Hyper-Threading and can calculate on up to 16 cores.



Laser 2000 GmbH · Tel.: +49 8153 405 5 · info@laser2000.de · www.laser2000.de



Special Development for the Pharmaceutical Industry

The German company Laetus develops and provides control systems for pharmaceutical packaging which captures the product optically by using high-performance digital cameras. But the variety of the cameras and so the warehouse costs increased, processes were getting inefficient. So the idea arose to standardize camera modules for Laetus. The Laetus iCam was developed, a compact camera module with an integrated LED flash. Inside the 100 x 60 x 40 mm housing are a modified AVT Stingray Board Level camera, a small M12 lens, and a LED flash. Illumination with red, white or UV LEDs is directly controlled by the camera and calibrated to its exposure time. The iCam is available in eight sensor varieties with resolutions from VGA (0.3 megapixels) up to 5 megapixels. Lens focus with 6, 8 or 12 mm focal length allows for perfect image quality using Allen screw adjustment.

Allied Vision Technologies GmbH
Tel.: +49 36428 677 0 · info@alliedvisiontec.com · www.alliedvisiontec.com

Bead Inspection Tool

Matrox Imaging announced Matrox Design Assistant 2.3, the latest release of its integrated development environment (IDE) for the Matrox Iris GT smart camera. It is a follow up to Design Assistant 2.2, which enabled the use of the built-in keyboard, video and mouse capabilities. Design Assistant 2.3's bead tool inspects material applied as a continuous sinuous bead, such as adhesives and sealants, and identifies discrepancies in application length, placement and width. For applications where mechanical fixturing of parts is impractical, the software's simplified fixturing automatically positions (i.e., x-y coordinate and angle) the region of interest (ROI) for a measurement or reading tool using the results from a locating tool. Design Assistant 2.3 IDE can now be installed and used on 32/64-bit Windows 7.

Matrox Imaging · Tel.: +1 800 804 6243
imaging.info@matrox.com · www.matroximaging.com

Images at up to 12 Bit Color Depth

The company IDS Imaging Development Systems GmbH announces powerful new functionality for its cameras of the GigE uEye SE and RE series. As of driver version 3.60, these cameras now support the transfer of the sensor's full color depth of up to 12 bit. The extended functionality provided by the new firmware is available immediately through a simple driver update in the PC. This way, even camera systems in the field can quickly and easily benefit from the new features. Besides the updated firmware, the driver software 3.60 comes with several improvements, including support of new sensor models, revised DirectShow and ActiveX interfaces, and added functionality in the viewer application. The driver can be downloaded for free from the manufacturer's web site.

IDS Imaging Development Systems GmbH
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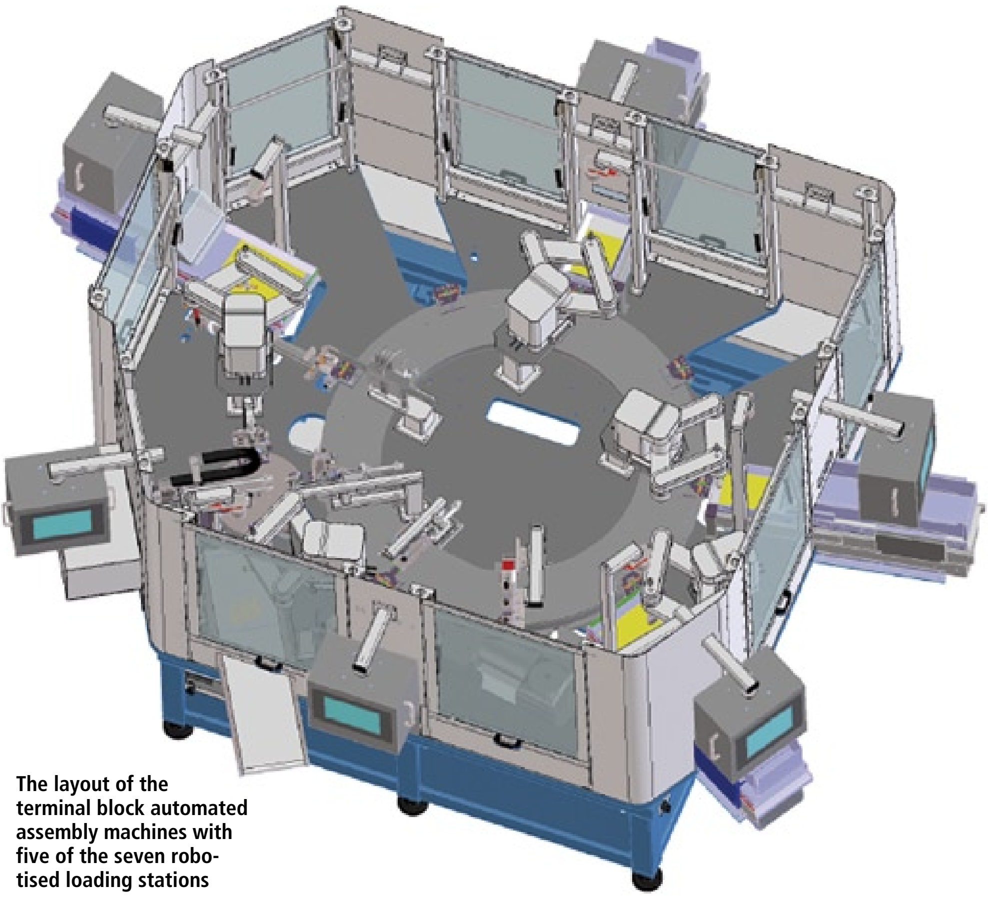
Tight Integration of Robotics and Vision

Market Changes Require Flexible Manufacturing

A number of changes and requirements of the global market place are responsible for the adoption of new concepts and strategies in manufacturing, collectively known as 'flexible manufacturing'. Some of these requirements are faster time to market, just-in-time production, smaller production lot, but also more and more competent and very aggressive players from the new economies of India, China, and Korea.



The layout of the terminal block automated assembly machines with five of the seven robotised loading stations
(Courtesy of AutomazioneBrazzale)

One aspect of flexible manufacturing is the capability to design and assemble machines and complete production lines that can easily produce a range of different products with a minimum down-time resulting from re-tooling, re-programming, and re-configuration changes. Thus, flexibility has become a major requirement and efficiency evaluation is now taking into account also the time it takes to switch the manufacturing process across different products.

Some of the key ingredients that have been added in the 'recipe' for flexible machines are these technologies:

- adoption of small, fast and accurate industrial robots, both SCARA (Selective Compliance Assembly Robot Arm) and anthropomorphic, replacing more conventional ad-hoc mechanics, especially in the feeding / loading of product components;
- adoption of machine vision as a means to increase flexibility for both robot guidance and quality control, hence providing also in-process inspection;
- development of a better and fully integrated software platform, covering all aspect of robot programming, machine vision, man-machine interface.

The latter point is quite important, since it represents a different approach when robotics and vision software, in fact the whole application, are developed jointly, instead of being considered two different systems.

Conveyor tracking application for the pharmaceutical industry

A brief description of three deployed solutions, machines co-developed with partnering companies, will highlight these concepts.

Automated Assembly of Terminal Blocks

The final product is composed of a plastic body, one or two metal conductors and few contact springs. The machine can assemble more than 60 different products that differ in size, type and number of contacts. Up to seven robots (Mitsubishi double arm SCARA) are used to load the components, which are picked from 'flexible feeders' (Flexfactory). Vision identifies the correct component among a 'population' of random parts

Face-powder compacting machine, complete with robotised loader and machine vision system
(Courtesy of Vetraco Group)

and performs a dimensional quality check before loading the part into the assembly fixture. Each robot is guided by an associated video camera that also controls the feeder.

Packaging of Pharmaceutical Components

Different plastic parts like dosing spoons or cups, dosing plastic syringes, plastic vials, etc. are picked from a continuously moving conveyor with a method known as 'conveyor tracking' in the robotics parlance. A single machine vision system provides the coordinates to two robots (Denso SCARA). The parts are made of transparent or trans-lucid plastic with highly reflective surface. Pulsed IR lighting solves the illumination issue. A twin conveyor (four robots, two cameras) and a transverse step conveyor (using a fifth Denso robot) load the parts to the box forming machine. Two more robots (Fanuc anthropomorphic) are used to load parts in bulk quantities.

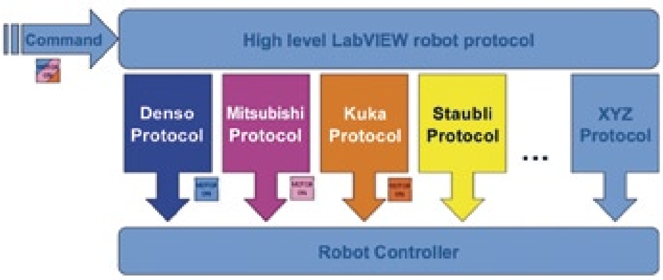
Loading of Cosmetic Face-powder 'Godet'

The French word 'godet' identifies the small metal tray holding the compacted face powder in a lady's face powder trousse. The size and shape of this part is determined by the overall design of the products according to the arcane and mandatory decisions of marketing. Flexibility is of paramount importance. The 'godet' are identified by a vision system that communicates the pick coordinate to an inverted SCARA robot (Denso) and furthermore controls the step movement of the feeding conveyor.

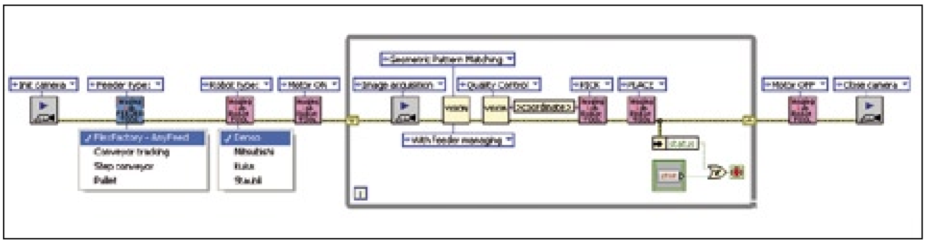
Multi Brand Robot Vision Library

The most common public image of an industrial robot is probably that of an automated welding cell for the automotive industry. However, the really interesting and fast growing areas of industrial robotics might be entirely elsewhere: from automated assembly to biomed. These new application areas require a very high level of flexibility, make use of limited pay-load, fast and accurate robots and integrate more and more machine vision systems.

Industrial robots have been on the market for a considerable time and different manufacturers are either competing for the same market segments or have specialised in different areas:



The 'abstraction layer' concept diagram: high level commands and specific robot protocol modules



Simplified representation of graphical programming of a complete robot vision application in LabView

SCARA rather than anthropomorphic, small and medium size robots rather than large heavy pay-load ones. Functionally, robots from different manufacturers are very similar so it is rather surprising that no standard programming language and practices were ever agreed among the robot manufacturing companies.

While a 'blind' simple pick and place application (for instance from a set of fixed 'pick' positions to a single 'place' position) requires a limited programming effort often carried out directly from the 'teaching pendant' of the robot, programming escalates rapidly in complexity when dynamic positions or dynamic cycles (as opposed to fixed ones) and close interaction with machine vision is required.

The path from robot manufacturers to robot end users usually requires the services of an integration company but the selection of a specific robot and hence a specific robot brand is often determined by the application requirements or by a choice imposed by the end users. It is not uncommon to see complete production lines where robots of different brands are deployed.

To overcome the lack of a common language for different brands of robots, ImagingLab begun few years ago with the development of a set high level tools in LabView, a graphical programming environment born in the mid eighties, that has become the 'flag' of National Instruments, and that has acquired since then a worldwide recognition. These tools would facilitate the programming of robots in complex applications and that would reduce programming costs, while allowing a rapid transition across different brands of robot. The idea of a 'hardware abstraction layer' was thus born, first strictly for internal use at ImagingLab, and later on developed into full LabView robotics library. This library offers a very powerful graphical programming software platform where it is possible to seamlessly integrate robotics, vision, external sensors data acquisition, sophisticated man-machine interface, and much more. In this way all the key elements of a robot-vision system are graphically represented, including the type of component feeders, brand of robot, part location algorithm, optional quality control checks and the generation of the pick and place coordinates. The actual control of the robot (inverse kinematic real time control and all related robot 'management') naturally remains with the original controller supplied with the robot.

Transition to 3D

The robotics libraries for LabView, at this time provided for Denso, Mitsubishi and Kuka robots, greatly facilitate the use of industrial robot arms directly to end-users that although familiar with many of the concepts related to industrial automation or other scientific areas are not necessarily at ease with the world of robotics.

Machine vision for robots is still mainly 2D. Robots, however, move in a 3D space, and have a lot to gain in the transition from 2D to 3D. Work is under way to ensure the integration of 3D vision technology with the robotics libraries.

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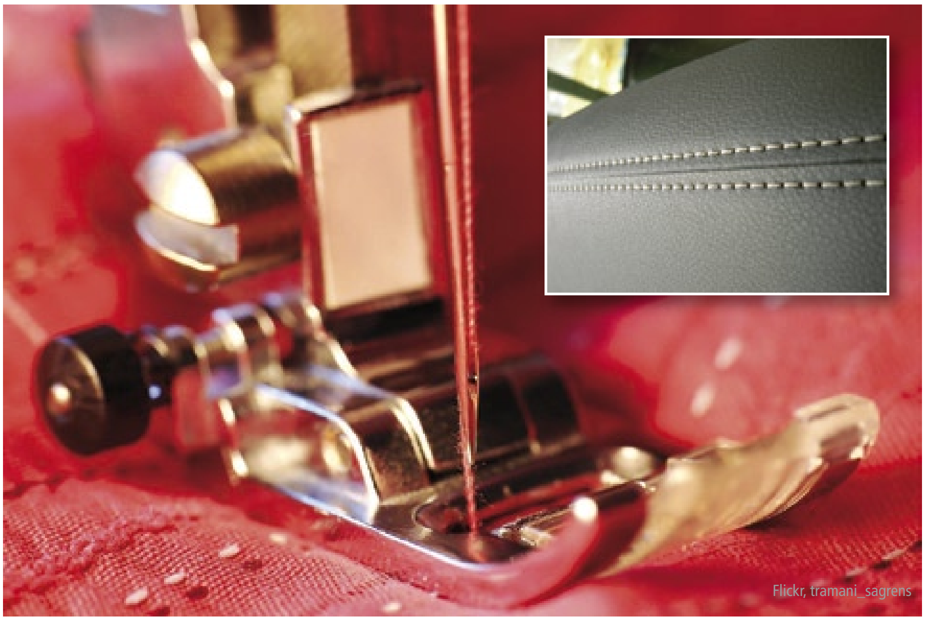
Exact Seams

Contour Curve Detection for Robot Path Correction

The fine seam sealing in the automotive industry is one of many industrial applications which are not running fully automated yet. Up to now, narrow tolerances of mechanical parts have required an individual inspection and treatment. Now a new generation of position detection set out to solve this problem.



Core of the application is the laser triangulation sensor LineRunner 300 from Pepperl+Fuchs


A special hook application nozzle ensures seam sealing directly at the door gap

A typical robot-aided application cell sets forth certain requirements for the processing of mechanical parts, such as part positioning, tolerances, and integrity. Correcting the robot path program by means of preset object position recognition is today state-of-the-art, but for many applications a single position correction of the robot path is not sufficient, however. New, additional technological means are required for accurate information about the contour curve of these parts.

VMT has, in close cooperation with clients, developed a new generation of position identification. The core of the solution is the Pepperl+Fuchs LineRunner which is based on the laser triangulation method and offers significant benefits. Thus with its compact design, the sensor can be installed on the robot easily. Furthermore, stud holes ensure the sensor replacement in a simple way whereby the sensor re-calibration is not required. As measuring laser an infrared laser diode is used which reacts robustly to ambient light interferences. The laser technology provides together with an intelligent lighting control reliable results also on diverse surfaces. A further advantage of the LineRunner is that no video signal wiring on the robot is necessary.

Optimal and Individual Robot Paths

The VMT BK (Bahn-Korrektur aka path correction) system covers the entire contour of the part. Moving along the part by means of the robot, the system registers the 3D position of every point of the part's contour along the path. With the aid of these coordinates, it is possible to correct the entire contour curve along the robot path. The result is an optimal and part-specific robot path, thus also a very accurately adjusted application.

All measuring points can be liberally edited. i.e., the position of individual measuring points can be manually shifted using an entry mask, the coordinates can be provided with offsets, and measuring points can be added or removed. The measuring points of application paths can be liberally allocated. Thus, the measuring results have influence on each individual application point of the robot path.

Robot Integration

An important advantage of the VMT systems is their easy operation and programming – this applies also to the VMT BK system. Completely integrated in the user interface, the system features the same operation philosophy as all other VMT machine vision solutions. The combination with standard position recognition and/or inspection tasks is possible, as the VMT BK software can be installed on the same hardware platform.

For simple integration of this technology in the robot, there is yet another supplementary module in the VMT BK system's software where all data exchanges are parameterized. These drivers are available for most robot-controlled systems deployed in the automobile industry (Kuka, ABB, Dürr, and Fanuc).

Field Test in Automotive Production

The contour-based path correction has meanwhile proven successfully its value with several automobile makers in various applications. For instance, in clinch flange sealing on vehicle doors and flaps, the clinch flange that joins the inner door panel with the outer door panel is sealed with PVC. The PVC-sealing of the seam is fully automated, using a robot and a suitable application technology. The quality standard for PVC-sealed seams is very high, because perfect sealing is important also from the "cosmetic" perspective. These seams are visible to the end customer and must therefore have an even appearance.

In order to be able to satisfy these requirements, the robot-controlled Line-Runner sensor has to move along the door contour continually, without halting at the measuring points. This facilitates accurate copying of the door contour and of the position in space. Upon receiving this information, the robot is capable of adjusting to the given vehicle's door and performing its application run.

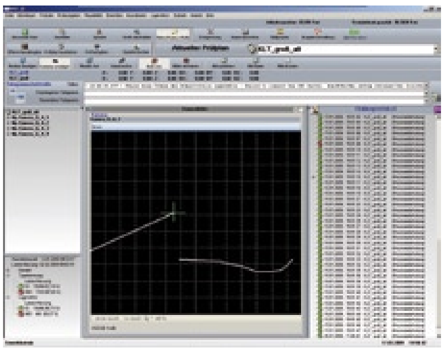
Gap Measurement for Collision Prevention

Since the application is performed with the door closed and the seams to be sealed are situated on the inner side of the door, the robot is fitted with a special hook application nozzle. The nozzle runs through the gap around the door. Typical diameter of the nozzle is 2.5 mm, whereby the gap is between 3 and 4 mm wide – depending on vehicle model. Since doors vary in their assembly position due to body shell tolerances, the gap may vary, too. This increases the risk of a collision of the application nozzle and the body. Such a collision would make the application nozzle useless. By extension, this would lead to machine-down time and loss of production.

In order to prevent such losses, the VMT BK System tests also the gap width during the measuring run. If the system finds that the gap is not sufficiently wide, the robot's application run is not permitted. Information on the different application tools stored in the system facilitates monitoring of collision danger also with different tools. This mode of operation is an important contribution to the overall plant availability.

Automated Sewing Tool

Another example of the VMT BK System's usability is taken from the automobile supplier industry. For the sake of visual betterment of vehicle cockpits, the robot applies artistic seams. Since such seams are within the vehicle crew's immediate sight range, an optically correct impression is very important. For this purpose, the VMT BK System defines the optimal application path for the robot: The path of a crimp situated on the cockpit is detected by the VMT BK system, and the robot's seaming tool is guided along this path with an accuracy of +/- 0.2 mm. Laser-based technology makes it possible to perform this application without a problem also on cockpits of different colors.



The VMT BK system features the same operation philosophy as all other VMT machine vision solutions

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Safety on the Roads

Tyre Tread Depth Measurement in Moving Traffic

Tyres are the top and foremost technical cause of traffic accidents. Worn tyres significantly prolong the braking-distance, and cause aquaplaning effects to happen much earlier. Legislative bodies have therefore installed a tread-limit of 1.6 mm. However, enforcement of adherence to this specification proves to be difficult: Up until now tread depth could only be measured manually on a static vehicle.

Operation of the ProContour H3D system on federal highway B34 near the company's headquarter in Waldshut-Tiengen, Germany

To automate this manual spot test the German company ProContour has now developed the system H3D, which allows for tread depth measurements in moving traffic without compromising the traffic flow. The system H3D aims towards the determination of reasonable cause for the subsequent manual measurements at checkpoints. The automated tread depths measurement guides the attention of the controlling bodies specifically towards vehicles operating on inadequate tyre quality. Of course, neither raise of suspicion nor personal data collection is executed by the system for vehicles with sufficient tyre quality.

The system H3D primarily consists of two components, the actual tyre scanner for the acquisition of the 3D surface structure of the tyre and the host computer for the subsequent automated tread depth measurement. For the acquisition of tyre data, the tyre scanners are submerged in the road. The scanners finish evenly with the road surface and are not being noticed by the driver. The wiring is routed below the road surface towards the roadside where the data acquired from the tyre scanners is accumulated in the host computer. The host computer serves as main processing unit and as operator terminal.

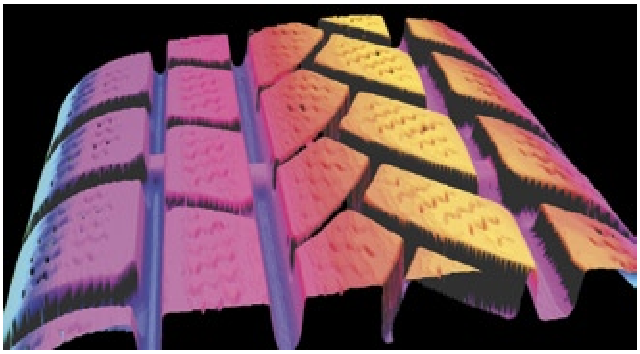
16,000 Images per Second

The tyre scanner mode of operation is based on the triangulation method. By deployment of special optical and mechanical components, however, the ordinary sheet-of-light principle is modified in such a way, that a periodic motion of the light sheet plane is achieved. Due to this technology, within a time window of around 2.4 ms (with vehicle speeds up to 120 km/h) the continuously forward moving tyre can be seen as a quasi-static object and its surface data can be measured in a planar manner. During this movement a high speed camera acquires up to 16,000 images per second and instantaneously calculates the height of the laser line in these images. Thus, yielding a height value for each column in the image, individual height values over the whole image are combined to a height vector. The aggregation of height vectors again is executed in image format with 40 lines per height image, thus enabling a camera to deliver up to 400 height images per second.

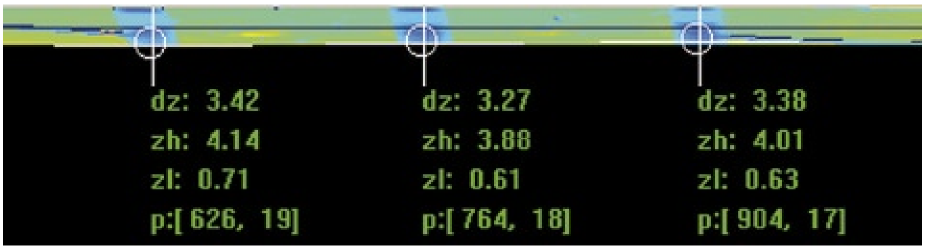
The area in which tyre data is acquired spans 30 mm in driving direction and 350 mm cross driving direction. The height of the acquisition region is 9 mm. The data transmission to the host computer happens via Ethernet through a Pleora interface. The maximum expansion stage for the system currently supports up to four cameras. Thus, the system produces data rates up to 23.4 MByte per second.

Automated Tread Depth Measurement in Three Steps

By means of suitable sensor technology within the tyre scanner, the presence of vehicles in the measuring field is detected automatically and this information is then sent to the host computer. While the vehicle crosses the measuring area, the data acquired by the cameras is being forwarded to a step-by-step further processing. The first processing step eliminates those height images, which by automated image analysis have been found to carry no usable image content. The second step then passes on the usable height images to the subsequent tread depth measurement.



3D surface-structure (false colour display) of the tyre as base for the automated tread depths measurement



Tyre height image with overlay of the determined tread depths

The automated tread depth measurement is a three stage process. In the first step, by means of local parameter estimation of polynomial models and data points – in conjunction with data filter algorithms – a plurality of elementary measurements is being acquired. A typical car tyre produces up to 200 of such elementary measurements. The second step sorts the elementary measurements gained in step 1 into logical groups according to proximity and spatial distribution. Each group of elementary measurements then represents a single tread on the tyre. In the final step of the measurement, for each group of elementary measurements a representative value is being determined, taking into account that within a group, both stochastic variations as well as systematic deviations caused by TWIs (tread wear indicators) may be inherent in the data. The employment of robust algorithms ensures that such outliers are ignored for the determination of the final result.

For the programming of the first generation of measuring algorithms, commercial image processing libraries were used. However, this approach was discarded due to the high number of special requirements. The currently employed second generation of algorithms and numerical methods is entirely developed by ProContour itself. All time-critical functions are implemented in C/C++. Higher level modules merely serving the data organization are implemented in the scripting language Python. Wherever possible and suitable, throughout the processing of the measurements, data structures and algorithms have been abstracted by objects and their classes, according to the paradigms of object-oriented programming.

Resolution and Measurement-Uncertainty

The systematic resolution per pixel position in the height image is given by design with 0.05 mm. Due to the local processing of a multitude of height values to a single elementary measurement, the measurement uncertainty is influenced by further factors, however. As the profile depth is the difference in height of two polynomials, the measurement uncertainty also comprises the quality of the fit of the polynomial model to the height data. Depending on the quality of the height data, the number of suitable height data is not deterministic. Due to the complex structure of the measurement device itself and the measurement algorithms, the approach to express the measurement uncertainty by GUM (Guide to the expression of uncertainty in measurement [ISO]) is not suitable.

For determining the measurement uncertainty, empirical methods are employed instead. Reference bodies with tread-like structures are used as inspection equipment. Typically, around 2,000 measurements of the same body are taken repetitively and the acquired data is then statistically analyzed. As a result, for the H3D system it was found that the measurement uncertainty is a factor 2 times the systematic resolution. For the specifically described system with 0.05 mm systematic resolution, the measurement uncertainty is given with 0.1 mm.

Conclusion

The system H3D offers for the first time a possibility to measure the tread depth on vehicles moving with a speed of up to 120 km/h in an automated process. Police or authorities are now able to run checks more effectively by being targeted right away to suspicious vehicles.

Systems with fewer requirements on vehicle speed are already operated at garages to alert customers to noteworthy and potentially dangerous tyre conditions.

Due to the high density of the acquired tyre data there is now also an option to determine the type of tyre (summer/winter). In addition, the detection of insufficiently tuned chassis parameter (track/camber) is already in the testing phase with partners from the automotive industry.

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Clearing the Box Smartly

Bin Picking: The Masterpiece of Robot Automation

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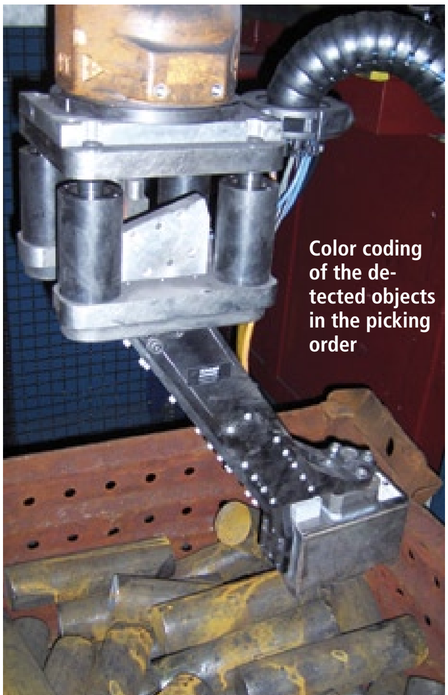
It is easy for a person to pick an object out of a container and set it down. Teaching a robot to do this is considered the ultimate challenge in automation. Unlike a person, the robot has no eyes, no sense of touch and no power of comprehension.

The automation supplier Arotec based in Augsburg, Germany takes up this challenge and awards the robot all the abilities which make it simple for humans to pick parts out of a bin. To do this the robot first needs visual abilities. For this, two kinds of sensors come into consideration: passive and active sensors. Passive sensors work like the human eye: they capture rays of light from their surroundings and transform the signal into a two-dimensional color image. There is no information about the distance of the objects captured in the image. As long as the object sizes are known, the object distance can be calculated from the object size in the image – or by means of a second camera and correspondence between the images. But, passive sensors have the same limitations as the human eye: If it is too dark, or by looking straight into a light source, humans can no longer discern details. In an industrial setting, constant lighting of the scene (e.g. during day and night shifts) is often only possible at great expense.



Color coding of the detected objects in the picking order

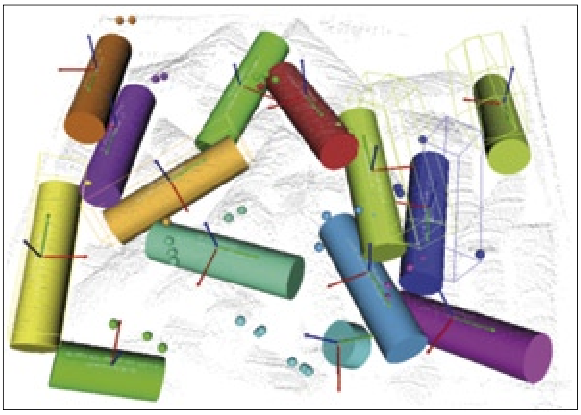
Better Eyesight in the Dark

Consequently, Arotec uses active sensors for its solutions: These project a light signal into the scene and register the reflected light. Active sensors are thus virtually independent of the ambient lighting. In industrial applications, two methods are primarily used with active sensors: In the time-of-flight method, a beam of light is emitted, reflected by the object and returned to the sensor. The intervening time provides information about the distance between object surface and sensor. In the triangulation method, a laser line is projected onto the object. This is observed by a normal CCD camera. The distance to the surface is calculated on the basis of the alignment of the laser relative to the camera and the laser line deviation in the image.

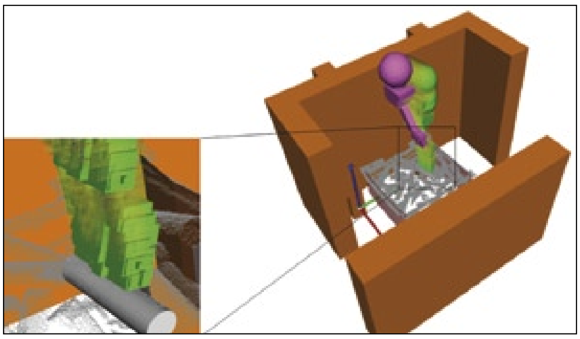
While passive sensors can capture an entire scene with a single image, active sensors often also require the relative motion. Most active sensors on the market only return a limited image acquisition area – generally a cross section of the image plane with the scene. To capture the entire scene, the sensor must be moved relative to the object. This motion provides an image with numerous three-dimensional points that define the surface of the scene. The image capture time is thus usually higher for active sensors; in the case of time-critical applications, it must be expertly incorporated into the robot cycle.

What Is What?

Unlike people, the robot observes without evaluating. In order to obtain a working automation solution, the developers have to teach the robot to distinguish between good = object and bad = no object. For this purpose, the image undergoes a number of process steps in which incorrect measurements are eliminated and sensor-related interference factors are minimized. This is generally followed by segmentation. Here, the points that belong to an object are grouped together. The orientation of the object can then be determined on the basis of distinctive geometric characteristics.



Motion path planning with gripper and surrounding



Robot and gripper in a real system

Focusing on the Right Object

Now, it is necessary to communicate to the robot the best gripping position for each detected object and in what order the objects should be gripped. This is because parts are often unsorted and hidden by other parts in containers. Picking such objects often results in collisions, or the objects slide around in the container or catch on one another. Intelligent definition of the gripping sequence simplifies the task.

It is useful to define several different points at which the object can be gripped. This increases the probability of the robot picking the correct part. Certain gripping operations of the machine will fail due to parts lying on or next to one another or up against the edge of the container.

Once the object and the gripping position have been clearly defined, a collision-free motion path has to be determined. For this calculation, the developers take the container, gripper, robot and the entire surroundings into consideration. Merely considering the objects that have been found does not suffice to ensure safe operation. The Arotec experts thus use the complete sensor data for collision detection – after all, there could be unforeseen objects in the container.

Interaction Is Decisive

All obstacles, the properties of the object (e.g. size) and the general conditions (e.g. distance from the container) have been taken into consideration. However, the object will only be picked up reliably if the sensor system and gripper system interact perfectly. In a harsh industrial environment, there are always interference factors, e.g. the measurement accuracy of the sensor. For this reason, the sensor used should be as accurate and high-resolution as possible. This is, of course, expensive. To keep the application cost-effective, Arotec seeks a compromise in the interaction with the gripper. A person compensates for interference factors with his sense of touch – without consciously thinking about it. In the same way, the gripper should be able to compensate for a certain degree of inaccuracy of the sensor or detect that the objects in the container have moved after one of them has been picked. Once this has been ensured, there is nothing to prevent successful bin-picking applications.

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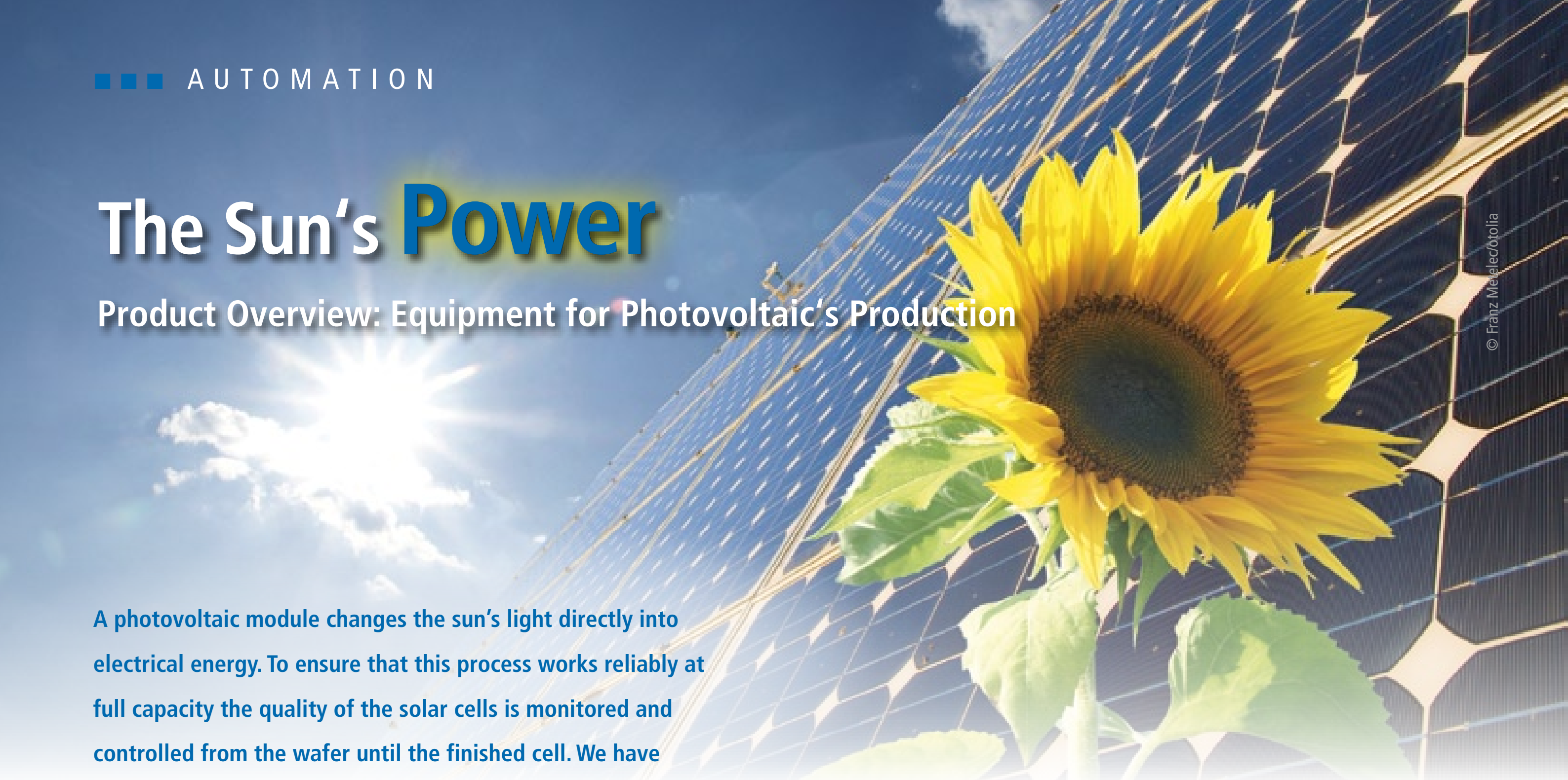


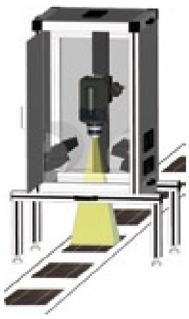
The Sun's Power

Product Overview: Equipment for Photovoltaic's Production

A photovoltaic module changes the sun's light directly into electrical energy. To ensure that this process works reliably at full capacity the quality of the solar cells is monitored and controlled from the wafer until the finished cell. We have compiled an overview for you which tools machine vision and metrology offer to solve these tasks.

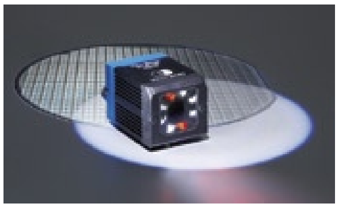
In the last couple of years, the size of solar modules has increased significantly. Modules with areas of up to 5 m^2 can only be inspected through destruction when using a standard microscope. In order to avoid this, **Promicron** (www.promicron.com) has developed a new type of microscope: the Solarpanel-Scope, **a portable light microscope with camera and eyepiece lens**. Flexible air and vacuum base pads can be used to lift the microscope by several micro meters thus the Solarpanel-Scope is sliding contact-free above the sensitive surface, i.e. of thin-film surfaces.

InfraTec's (www.infratec.net) inline test system PV-LIT **inspects solar cells fully automated** and guarantees a 100% quality control. The corresponding inspection criteria (e.g. limit values, temperature levels, number and size of defects) are defined by the users themselves. Flexible data interfaces (e.g. Ethernet, Profibus) permit optimal adjustment to the individual conditions on site.



The inspection systems from **pi4_robotics** (www.pi4-robotics.com) combine three different methods (back light, top light and electroluminescence) to **detect all defects** before assembly. The systems are integrated into the stringer, before the layup, as a complete test cell for modules before or after lamination or directly integrated into the flasher. If desired, inspection data and images can be stored to a separate server.

The vision solar sensor FA 46 from **Sensopart** (www.sensopart.com) examines cracks and defects of crystalline solar cells. On account of its high precision, it closes the gap between PC-based image processing systems and simple contour-comparing vision sensors. The sensor **independently recognizes different wafer or cell forms** (e.g. mono crystalline and poly crystalline). This makes a learning of contours or patterns unnecessary. During operation the FA 46 measures each wafer individually, independently of rotation, and, thereby, achieves a high dependability.



The company **Eckelmann** (www.eckelmann.de) developed a vision system which inspects wafers for defects in 0.8 seconds and measures the parts with an accuracy of 50 µm. Core of this test-bench is a high resolution GigE camera of the uEye series from **IDS** (www.ids-imaging.com). This camera features a CMOS sensor with a resolution of 2,560 x 1,920 pixels. The system captures two different images from **the inspected wafer while changing the lighting**. Red LEDs screen the silicon wafers to make continuous cracks visible. White top light enables the detection of contaminations and defects on the surface as well as non-continuous cracks.

Vision Components (www.vision-components.com) now presents an intelligent camera which is able to **record and process electroluminescence images for quality checks of solar wafers** and photovoltaic modules. The VC4067/NIR features especially photosensitive technology which provides high-precision images at wavelengths up to 1,100 nm. It reliably detects and identifies defects such as micro cracks, shunts, and disconnected fingers. The 2/3" CCD sensor has a 1,280 x 1,024 pixel resolution, providing a maximum frame rate of 14 fps and a freely programmable exposure time from 5 µs to 17 s.

Spectroscopy Solutions and Sun Light Simulators

The flash of a solar simulator is used within manufacturing of solar cells for the classification of cells according to the cells efficiency. For the control of such solar flashers **Ocean Optics** (www.oceanoptics.eu) offers now SolarSpec – a system which provides the necessary accuracy and resolution to measure and analyze the performance and stability of the flasher. The measurement is triggered by an optical sensor which reacts on the increasing intensity of the flashlight. The calibration of the spectrometers allows for exact analyses of the signal according to the relevant norms and therefore provides information **about intensity and spectral distribution of the flash**.

Also, **StellarNet** (www.stellarnet.us) launches a new spectroradiometer system on the market, announces **Laser 2000** (www.laser2000.com). The system is designed to **characterize and evaluate light emissions** according to industry standards used for solar simulators. The complete NIST traceable system consists of a portable UV-VIS-NIR fiber optic spectrometer and fiber light receptor. The Solar Match Monitor application calculates spectral irradiance for each 100 nm bin from 400 to 1,100 nm and compares the results to the ideal percent for each bin range per IEC/JIS/ASTM.

The challenges of the spectrometer technologies are sun light simulators with pulse times less than a few milliseconds. For these applications, the knowledge of the trigger behavior is essential next to the reading behavior. The MultiSpec Solar from **Tec5** (www.tec5.com) is available with trigger and diffuser unit for the spectral range up to 1,000 nm as well as up to 1,700 nm. Furthermore, the system **measures in the process the reflection and color of the absorber layer**. With the direct method, the measurement of the layer thickness is more precise than the color value estimation of standard camera systems.

For process optimization of solar thin film modules **Dr. Schwab Inspection Technology** (www.schwabinspection.com) offers **spectrometer-based layer thickness measurement systems** which also enable the characterisation of surface structures. Simultaneous multispot measurement – typically 40 or 80 points over the sample's width – allows full-surface evaluation within cycle time. Effective process control is supported by a database module, allowing comprehensive statistic evaluations including trend analysis.

Cameras, Lenses and Telescopes

Photonfocus (www.photonfocus.com) offers a camera which inspects solar cells. It is based on the detection of electroluminescence radiation. The uncooled camera with CameraLink interface exhibits an A1312 CMOS image sensor from Photonfocus which was developed for machine vision tasks in the visible range as well as in the NIR range. The resolution of the new sensors is 1,312 x 1,082 pixels with a pixel size of 8 µm x 8 µm and a fill factor of more than 60%. Therewith, Photonfocus offers to the solar industry a camera with **sufficient image quality at low exposure times** (400–800 ms) which can be used in production lines for cells and modules.

The right lenses have to be chosen that cameras detect the electroluminescence radiation with sufficient sensitivity. In order to bring every available photon onto the sensor, **Linos** (www.linos.com) offers **special lenses with an outstanding transmission** of up to 98% in the wavelength range of 900–1,400 nm.

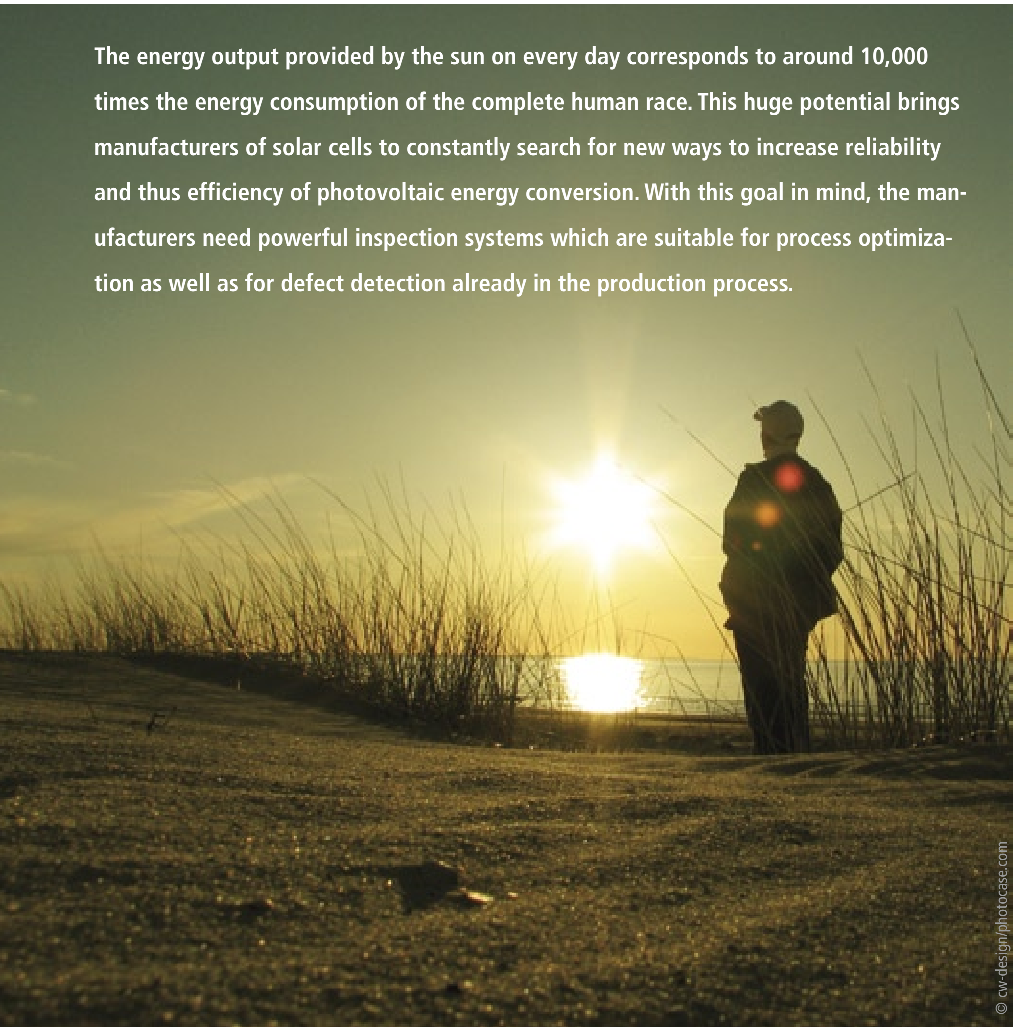
At the end, the **front metallization** of the almost finished solar cell is inspected regarding to its quality. For this task the High Brightness Light Line from **Schott** (www.schott.com) is suited. The precise and homogeneous light line provides the high contrast for the inspection of metal structures at surfaces. For the inspection of solar cells the company recommends the usage of red COB LEDs in 300 mm standard modules.

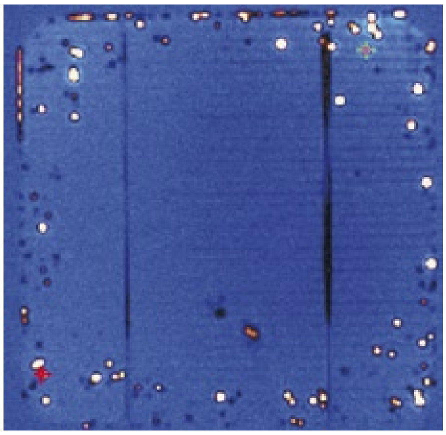
As a non-contact tool, the laser minimizes the risk of breaking while processing the brittle wafers. To **adapt the laser beam's diameter** to the demanding task, **Sill Optics** (www.silloptics.de) offers corresponding telescopes. For 355 nm, 532 nm and 1,064 nm, there are different expansion ratios available from 1.0x until 20x.

Towards the Sun

Active Thermography Improves Quality of Solar Cells

The energy output provided by the sun on every day corresponds to around 10,000 times the energy consumption of the complete human race. This huge potential brings manufacturers of solar cells to constantly search for new ways to increase reliability and thus efficiency of photovoltaic energy conversion. With this goal in mind, the manufacturers need powerful inspection systems which are suitable for process optimization as well as for defect detection already in the production process.





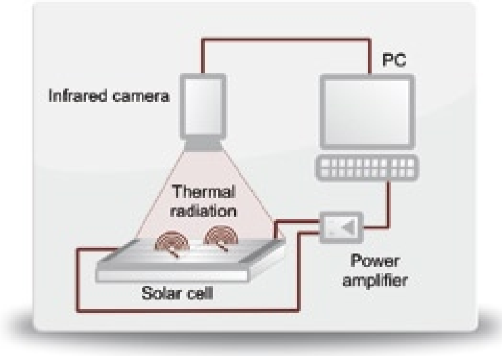
Localizing shunts in the infrared image of a DLIT inspection

During the manufacturing of solar cells, even the smallest flaw can have a devastating effect on quality. This is due to the high number of highly precise production steps. Therefore it is important to detect any possible defects at an early stage, which is why rigorous quality controls are carried out after every production step. This type of step-by-step monitoring and analysis enables fast defect detection, as well as the containment of the defect sources, so corrective actions can be rapidly applied optimizing the production.

However, in order to achieve a good level of solar cell production, engineers have to rely on data, whose acquisition tends to be very time consuming. To detect substrate contamination, e.g., manufacturers normally use the four point resistance calculation, whose space-resolved procedure can last several hours. The company Automation Technology has developed an alternative solution that provides equally accurate results, however in just a fraction of the time. The system is named IrNDT-SolarCheck and it applies the principles of LockIn thermography. Because of its modular design, it supports multiple inspection methods covering different production defects and material characteristics.

Dark LockIn Thermography

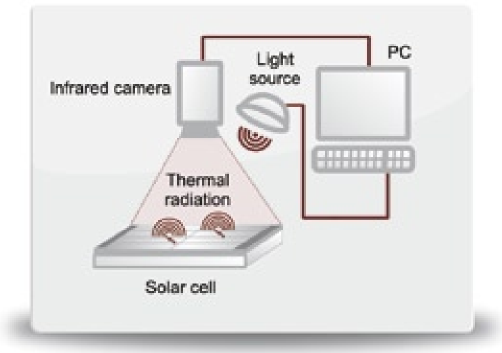
Dark LockIn Thermography (DLIT) is a method for the thermographic inspection of solar cells. It implies that a modulated power supply is connected to the solar modules either in forward or in reverse current. During the measurement, an infrared camera records the thermal radiation generated by the flow of current throughout the modulation. The frequency at which this modulation is performed is determined depending on a variety of factors. Among them is the diffusion length of the semiconducting material as well as its thickness. The desired resolution and the available inspection time also need to be taken into consideration. "The LockIn technique enables the enhancement of the thermal resolution when compared to standard thermography," explains Dr. André Kasper, one of the general managers of Automation Technology GmbH. "For example, a typical high-end infrared camera has a thermal resolution of around 20 mK. However, through the application of the LockIn technique in combination with our analysis algorithms we can achieve a thermal resolution in the range of µK, so even very small shunts can be clearly identified." A shunt is a local low-ohmic-resistance, which generates a leak current that lowers the efficiency of a solar cell. The appearance of shunts can result in a systematical manner, depending on different parameters during the manufacturing process; it can also vary from solar cell to solar cell. This means that in order to assure the high quality of the final product, 100% of the production must be inspected. The inspection process applying DLIT however can be carried out non-destructively in a time frame of below one second.



Principle of the DLIT method

Illuminated LockIn Thermography

Another method for the detection of shunts is the Illuminated LockIn Thermography (ILIT). In the same way as with DLIT, this inspection technique comprises the excitation of the solar modules through a periodical modulated signal. This signal, however, is not applied through an electrical contact of the cell, but through a light source. This modulated illumination excites the charge carriers at the P/N-transition on the solar cell, and generates in this way a photocurrent in the semiconducting material. Should there be any local ohmic shunts or not-linear shunts in the semiconducting material, then a small compensating current will flow through them generating a small local heating. The measurement of the resulting temperature variations is once again performed with the method of LockIn Thermography. On the contrary to the DLIT inspections, for ILIT no contacting of the solar cells is required. This enables the ILIT method to perform a contact-free inspection at an earlier step during the manufacturing process, even while the solar cells are not yet contacted.



Principle of the ILIT method

Characterization of Solar Cells

For the photovoltaic industry not only methods for the identification of defects are very important, but also solutions for the improvement of the performance of the solar cells. Here not only the quality assurance during the manufacturing is essential, but also the composition of the raw materials used. “Active thermography has a wide variety of applications,” remarks Dr. André Kasper; “because it helps determine the life-cycle-duration of the charge-carriers in the semiconducting material.” This can be achieved by a DLIT or ILIT setup in combination with a heated sample carrier. The inspection procedure is based on the dependence of the infrared emission from the generation of free charge-carriers in the semiconducting material. The acquired images enable the spaced-resolved determination of typical characteristics such as the concentration of charge carriers, or even the determination of their life-cycle duration.

Improvement of Quality and Efficiency

Inspection equipments based on active thermography support a wide variety of applications for the non-destructive testing of crystalline and thin-layer solar cells. Compared to other methods, these techniques enable a fast and reliable detection of shunts, micro-cracks, defect contacts, etc., as well as the determination of the properties of the materials used. Because these systems can be integrated into fast measuring cycles, they are applicable not only for process optimization but also for the quality assurance through a complete inline inspection of the manufacturing process. Therefore, LockIn thermography represents a major improvement for the quality and efficiency of solar cells production.

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Elevated Temperature

Automated Infrared Thermography for Industrial Processes

For the optimization of industrial processes, the temperature within its local and temporal progress is often a determining parameter. But conventional temperature measurement methods are insufficient to record crucial temperature deviation continuously with the required amount of data and at the required speed without any process interferences.

Infrared thermography represents an efficient method for recording surface temperatures of the to-be-tested products and equipment components in a non-contact, non-destructive and non-reactive manner. On the basis of the temperature distribution current objects' states can be evaluated as well as deficient process parameters revealed. This effect is based on the physical context of solid objects radiating at a temperature above absolute zero, and therefore sending electromagnetic waves. On recording this radiation and its intensity, surface temperatures of the device under test can be determined with respect to their emissivity. Modern advanced thermographic systems are capable of converting received radiation intensity into temperature values in a precise manner through highly sensitive focal-plane-array-detectors. Temperature values can be further illustrated as cross-fade with false color in order to display dynamic processes with high data density. One advantage of infrared thermography is that it is not necessary to interrupt any operation while monitoring temperature distribution and the fact that thus the inspection processes can be fully automated.

Process Monitoring

Typical applications, where temperature distribution is monitored inline with the help of infrared thermography, are especially the monitoring of manufacturing processes with critical temperature states, in particular injection molding and die casting, compression molding and thermoforming. For numerous further processes, such as hardening, thermal spraying, welding, soldering and bonding, the monitoring of the temperature distribution is helpful. Another complex is to be found in the field of quality assurance, for instance with the final inspection of electronic, electromechanical, and mechanical components and assemblies, respectively.

The company InfraTec located in Dresden, Germany is specialized in products and services in the field of infrared technology. The range of services includes among others the delivery of turnkey thermography automation solutions – starting from problem analysis up to the delivery of turnkey systems as well as their maintenance and additional training for operators.

Modular Design

The stationary infrared monitoring system Indu-Scan, based on flexibly config-

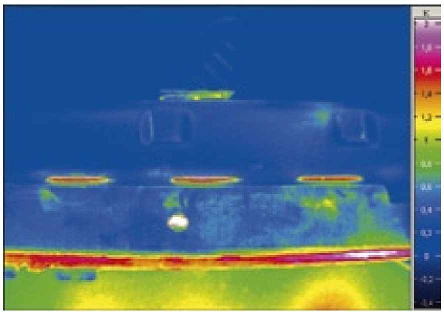
Automated thermographic measurement system Indu-Scan monitors the sheet metal manufacturing: On-site thermographic camera installation in protective housing with water cooling and air flushing

InfraTec's automated thermographic testing system for non-destructive testing of body panels in the automotive industry

urable modular building blocks, consists of diverse industry proven components and therefore fulfills various demands. Normally, thermographic camera units are installed in close distance to the monitored process. This frequently requires a special protective camera housing for withstanding rough ambient conditions. The image acquisition can be synchronized with the process rate on demand. Data is transferred onto an industrial PC via data cable variable in length or via optic fiber cable. In the evaluation unit, current data analysis is realized according to the predefined criteria. Statistical parameters, such as average value, maximum, minimum or standard deviation of parts of the thermogram can also be monitored just as single measured points. Measurement data can be continually recorded ensuring complete documentation of the temperature distribution during a specific stage of production. Furthermore, on exceeding or underrunning preset threshold values, the following activation of switch contacts may serve as possible warning signal. If measured temperature is needed for regulating process variables, it can also be transferred as analogue or digital signal. Systems, especially adjusted to the respective measurement task, monitor processes continuously, alert in case of thermal deviation or sort out defectively manufactured items.

Heat Flow Thermography

Product properties can also be tested through a thermal pulse subsequently injected into the test object. In recent years, the so-called heat flow thermography has been established as an efficient infrared testing method which, for instance, allows detecting problems in joining processes and other hidden defects. The thermal energy is injected into a test object by using radiant heaters, flashbulbs or hot air stimulation. Then, geometry and thermal properties determine the heat flow‘s temporal and local distribution of the test object. Over the course of time, a respective temperature distribution on the test object's surface is formed which is recorded with an efficient thermographic camera. Special software analyzes the acquired thermal images, evaluates them according to specific criteria and further creates a crossfade with false color. Heat flow thermography, as imaging method, enables a fast detection of defects and simple test result documentation. It is applied in serial production both for testing offline as well as inline. The scope of application encompasses not only quality assurance for bonding, welding, soldering and other joining processes but also detection of cavity, material defects of composites and cracks in metals.



Thermographic image of a laser weld seam on a body panel

Appropriate Camera Technology

Whereas cooled high-end thermographic systems with focal-plane-array photondetectors featuring highest sensitivity and frame rate are deployed to advanced measurement tasks in heat flow thermography, process heat-based thermographic automation solutions mainly rely on compact and very robust uncooled microbolometer camera technology. Depending on the type of camera, available image formats range from 120 x 160 up to 1,280 x 960 IR pixels, and furthermore, it is possible to identify smallest temperature gradients up to a few mK. On acquiring very fast processes, frame rates up to 3,000 Hz can be achieved.

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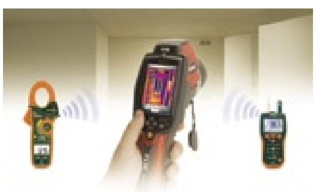
Not Visible?

Product Overview: Thermography and Infrared

With thermography technology thermal images can be generated. Since numerous processes, like welding or heat bonding, naturally produce thermal patterns it is obvious to use these images for quality control and diagnostics. For this, cameras are needed which detect the radiation invisible for the human eye.

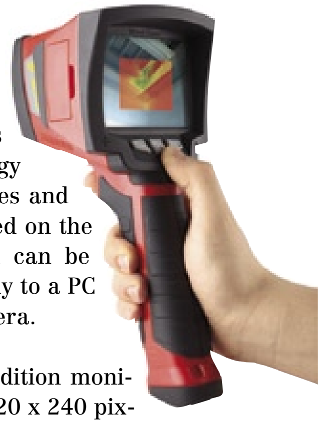
Fluke's (www.fluke.com) thermal imaging camera features a high thermal sensitivity and image quality. It makes use of powerful sensors with 320 x 240 pixels. In particular, the model Ti32 is developed for inspection tasks and technical process applications in the industrial field. Fluke's patented IR-Fusion technology combines high resolution thermal images with visual images. The modular-built SmartView software supports displaying, documentation, processing and analysis of thermal images.

For its infrared cameras, the company **Flir** (www.flir.com) presents a new technology: Meterlink. This includes a Bluetooth connection which ensures the data transfer from a current clamp or a hygrometer to a Flir infrared camera. The information is transferred directly into the corresponding infrared image. The latest generation of the Flir T series features an image transfer function for radiometric live data (image streaming). With this, the user is able to monitor a process over a period of time.



Also **Goratec Technology** (www.goratec.com) provides new infrared cameras, the Thermo Gear G100 and G120. **NEC's** (www.nec.com) G120 is an uncooled infrared camera with Gyro panorama function and vibration alarm. It exhibits a plug & play USB 2.0 interface for data transfer and video output. The company offers with the latest version 5.1 of the thermography studio a software grown over years for numerous thermal imaging applications.

The company **Infratec** (www.infratec.net) has now a completely new developed high-end camera series, ImageIR, in its portfolio. It was designed especially for the non-destructive material testing as well as for the process monitoring and features precise and robust fine mechanics for a radiometric stability. The temperature resolution is typically better than 0.02 K at 30 °C object temperature. With the analyzing software Irbis 3 professional, the camera series represents an efficient tool for demanding thermographic measurements.



The new thermal imaging camera EasIR-4 from **Wöhler Messgeräte Kehrgeräte** (www.mgkg.woehler.de) enables error diagnoses immediately on site. This works with an image-in-image technology on a 3.2˝ display. More than 2,000 images and corresponding audio files can be captured on the SD card or in the internal buffer, and can be transferred with an USB interface directly to a PC by using software supplied with the camera.

For challenging tasks in the field of condition monitoring, infrared resolution of more than 320 x 240 pixels is necessary. Due to the fact that high-end cameras represent a significant investment, the company **viZaar** (www.vizaar.com) offers different possibilities: Besides buying and leasing there is the try & buy program (the rent for trying out the camera is credited against the price to buy). But the company also offers complete thermographic tests by certificated thermographs.

Thermal Imaging is more than image processing of temperature profiles, in particular when it is used as fully automated solution. This is well known by the company **Ingenieurbüro für technische Messungen** (www.thermografie-dienstleistung.de) and accordingly their services are offered from consulting over field trials to feasibility studies. The company supports their clients also during implementation and until the end of the whole automation process.

Thermal imaging cameras require special lenses. Therefore, the company **Sill Optics** (www.sillop-tics.com) expands its product range with a thermographic lens with 50 mm focal length and an f-stop number of 1.5. With IR detectors it works vignette-free up to an area of 18 x 18 mm, the image circle is 27 mm. By using the full image circle, the picture angle varies between +15 and -15°.

Combined Precision

The 3D measuring microscope Leica DCM 3D combines confocal microscopy, interferometry and color imaging in one sensor head. The device works with dual-core technology, is available in several configurations, and suits best for contact-free 3D surface measurement. The Leica DCM 3D offers fast analysis of the micro- and nanogeometry of material surfaces to an accuracy of 0.1 nm. A confocal microdisplay is positioned in the field diaphragm. Two light sources and two high-resolution CCD cameras produce unlimited field depth and highly precise 3D results. The system requires no mechanically moving parts and is therefore practically maintenance-free.

Leica Microsystems GmbH
Tel.: +49 6441 29 0 · info@leica-microsystems.com · www.leica-microsystems.com

New Vision and Multi-Sensor Measuring Systems

Hexagon Metrology is introducing a wide range of vision and multi-sensor measuring systems to the market under the Optiv label. Five series are available – from the basic model to a high-performance instrument for measurements on the nano-scale. The multi-sensor technology in the Optiv product range combines optical and tactile measurements in one system. Set up for 2D or 3D geometry, the system carries out measurements using the most suitable sensor, depending upon the material, reflection characteristics and accuracy requirements of the inspected item, with or without contact. Optiv supports measurements using video sensors, tactile sensors, through-the-lens lasers (TTL-lasers) as well as the innovative chromatic white light sensors (CWS). Optiv measuring systems are ideal for the quality assurance of components in the automobile industries, electronics industries, as well as in tooling and mould making.

Hexagon Metrology · Tel.: +44 20 860 072 40 · www.hexagonmetrology.com

Automatic Correction on Free-form Bending Machines

More tube benders need the right measuring systems which take the particularities of complex free-form tubing into account. This is where Aicon's optical measurement system TubeInspect offers an ideal solution. It carries out very precise testing of free-form tube geometries with the help of high-resolution digital cameras. But now Aicon has gone one step further: With immediate effect the company based in Braunschweig, Germany, offers an additional interface that connects TubeInspect directly with the free-form bending machine. This results in automatic correction values being identified for the formed tubes and transmitted to the bending machine. Thus set-up time is shortened considerably. A close cooperation with the bending machine manufacturer Wafios from Reutlingen has made this new development possible.

Aicon 3D Systems GmbH · Tel.: +49 531 5800 058 · info@aicon.de · www.aicon.de

High Speed Camera Camera with CMOS Sensor

The new VDS Vosskühler CMC-4000 camera achieves up to 200 images per second at a resolution of 2,320 x 1,726 pixels. Owing to a limitation of the read-out area (ROI) the image rate can even be considerably increased. The camera is equipped with a global-shutter sensor recording all pixels simultaneously and enabling in this way the exact recording of fast moving objects. The CMOS-sensor with 10 bit AD-converters, used by VDS Vosskühler, achieves excellent and noise-free images in connection with the camera internal fix-pattern-noise correction. As digital output the interface Camera-Link (10 Tap Full) is available.

VDS Vosskühler GmbH · Tel.: +49 541 80084 0 vds@vdsvossk.de · www.vdsvossk.de

Interview with Dr. Norbert Stein, Managing Director and Sole Shareholder of Vitronic

INSPECT: Dr. Stein, your company Vitronic is today one of the leading turnkey suppliers for machine vision worldwide and for quite a time already focused also on areas outside of the traditional production-related applications. In which fields is Vitronic mainly active today?

N. Stein: Vitronic has been supplying machine vision systems from standard products with modules that can be expanded in accordance with customer specifications to individual customized solutions for 25 years. We develop, manufacture and sell these systems ourselves. The customers therefore receive turnkey systems – from hardware to software – from one source. Vitronic is active in three fields: industry, logistics and traffic technology. In these fields, we concentrate on classic machine vision solutions used in factory automation, camera-based identification systems for reading codes on packages, as well as laser-based vehicle speed measurements. In short: we have accepted interesting challenges that we can solve with machine vision in the three aforementioned fields.

Do you expect significant growth for machine vision in factory automation within the next couple of years, or do you see future growth more in the so-called non-industrial applications?

N. Stein: I see enormous potential in both fields. In factory automation, machine vision still is often used for the final inspection. However, it is economical to integrate in-line machine vision systems right into the production line. Production processes should be actively optimized and resources should be conserved with the aid of machine vision. Consequently, the topic „Green Automation“ will play an important role in the future.

There will also be potential areas of growth for our industry in new technologies – whether they concern new materials such as nano- or composite materials or entirely new concepts such as the change to electric drives in the automobile industry.

In many non-industrial applications such as agriculture or security, our industry is still in its infancy and will not have exhausted the full potential for quite some time. One of many examples is the detection and intelligent routing of flows of pedestrians in metropolitan areas or at large events.

Machine vision has an enormous potential for growth in the consumer market that was triggered by the integration of complete machine vision systems into mobile telephones and compact cameras. Whether it is the automatic translation of the menu in a restaurant or the recognition of products on store shelves for an efficient shopping process, there is a huge market for more or less (non-)useful applets.

Which are the remaining technical challenges for machine vision that still need to be solved? Or is the issue today more the integration of proven technology into ever new applications?

N. Stein: There is no lack of topics concerning algorithmics, or electronic and optical hardware: neither in basic research nor in application development. With respect to practical considerations, it becomes more and more important that the systems can be easily operated and adapted by the customers. This problem is more or less solved with respect to simple inspection tasks. However, the customer also expects this for complex inspection tasks. It must be possible to easily integrate the systems into the respective facilities and to easily adapt the systems when requirements change: modular solutions that can be intuitively operated.

Machine vision still is almost exclusively associated with the processing of standard camera images. In this context, it is important to think outside the box and to take into consideration other spectrums and other multi-dimensional sensors in order to broaden the field of application.

For many years you are very much engaged on an honorary basis in the VDMA (Verband Deutscher Maschinen- und Anlagenbau, German Engineering Federation), most recently as the Chairman of the Robotics + Automation Association Board. What motivates you to invest your time and energy into association work?

N. Stein: The only way to accomplish something in this industry is to act as a strong association. Only in this way economy, politics and society can be sensitized to our industry and an image can be established. In a federation of companies under the umbrella of an association synergies can be optimally utilized and transparency and flow of information can be increased. This also makes it possible to close ranks with research facilities and universities in order to promote young talent.

Founded in 1984, Vitronic employs today a staff of over 300 in seven locations worldwide, and is still completely privately owned. What is your success factor and which advice would you give to young entrepreneurs in machine vision today?

N. Stein: If I were to tell you, it would no longer be a secret. But I probably am not fully familiar with this secret myself. I believe that I have done quite well in being an equal among equals and in providing my employees the chance for evolving and being comfortable in the company. For young engineers, we offer a highly interesting work environment, in which research, development and customer experience are ideally combined. We take the social „comfort factor" seriously and offer an above-standard work environment. Toward our clients, we are extremely motivated, customer-oriented and highly competent. We have worked hard to establish our reputation as a technologically leading and reliable company, the products and solutions of which reflect this. Fortunately, word gets around.

The only suggestions I have for entrepreneurs are to prepare as thoroughly as possible and to question in detail why future customers should feel like they must place orders with him, the young entrepreneur. He can make the leap if he has a conclusive answer to this question and adequate knowledge of his future competitors. In the last 25 years, I have met very successful company founders, but unfortunately also many who invested their lifeblood and only reaped debt. Nevertheless: good ideas and strong commitment are no guarantee for success, but an important building block thereof.

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Preview

The next issue of INSPECT will be the PRO-4-PRO special edition, published in cooperation with the trade journals messtec drives Automation (MDA) and GIT SICHERHEIT+MANAGEMENT.

PRO-4-PRO (Products for Professionals) is a kind of annual “Best of…” of the GIT VERLAG‘s online industry database: www.pro-4-pro.com/msr, published in German language. This print publication gives a very comprehensive overview about products from the areas of machine vision, sensors, security, metrology, and automation, rounded off by in-depth reports from the Control and the Automatica trade shows.

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