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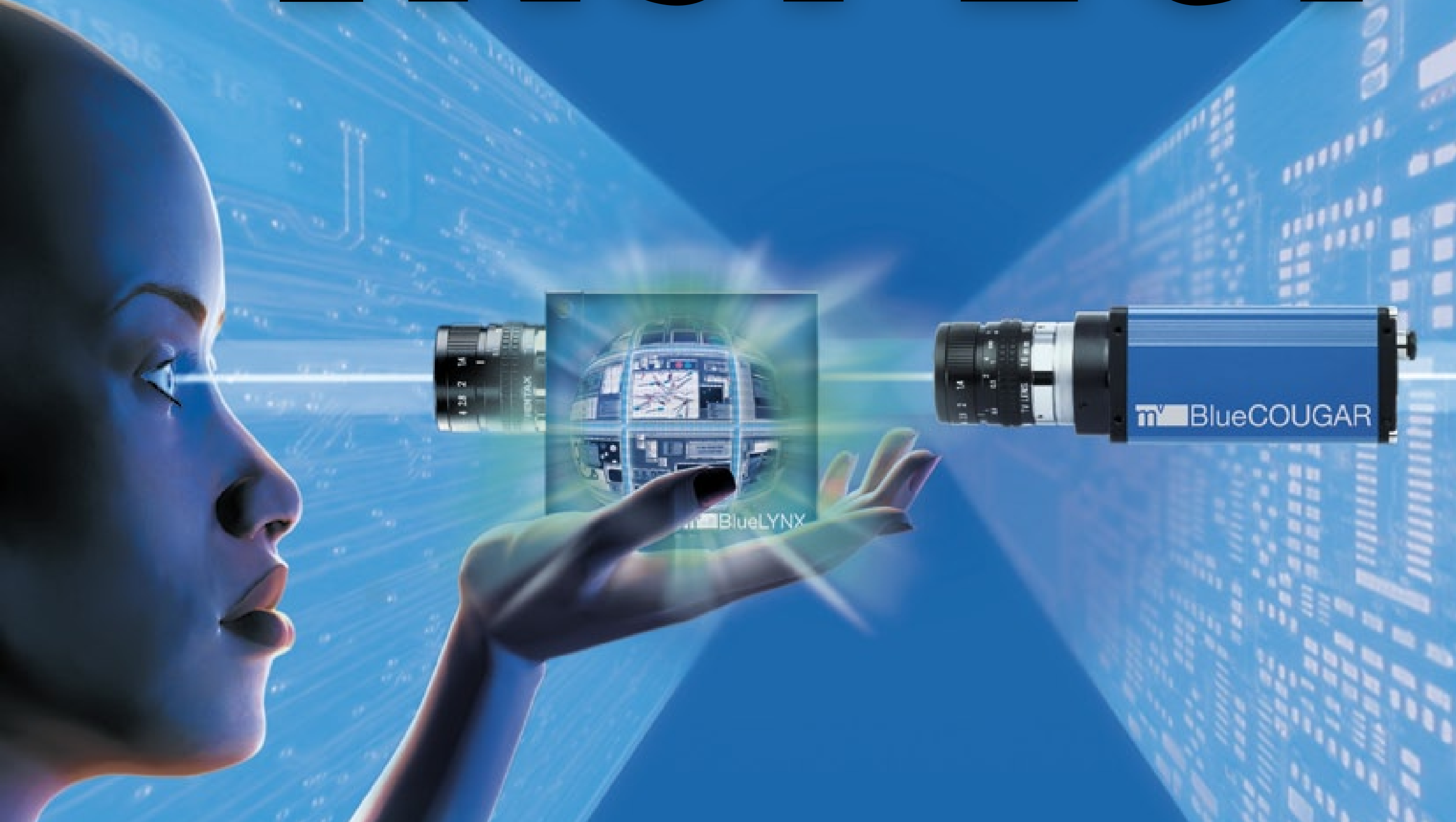
INSPECT



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Historical Accidents

Do you know this? Labeling problems? We are all talking about the same thing, but everybody uses a different term. Let´s not even talk about rolls, buns, baps or biscuits here. Let´s talk about Vision Sensors, Intelligent Cameras and Smart Cameras. And here is the question: where does one start and the other stop? For some a Vision Sensor is nothing more but a low cost product; for Bill Silver, co-founder of Cognex, it is something "going to be much more common in machine vision moving forward". Therefore it is not surprising for him that the problem of the pixel grid is overcome for the first time in such a low cost and easy-to-use product. Learn more about the historic accident which originally caused this surprising fact in our interview with Bill Silver in this issue.

The Vision Sensor – once aimed at lifting the world of Machine Vision up to new dimensions has arrived in reality meanwhile. True, a lot of vision applications can now be solved that up until the advance of this new technology could not be addressed for economical reasons but the main challenge still remains. There is and there will be no off-the-shelf machine vision system solving all tasks. It did not change that each application still presents new tasks for user and supplier. Engineering remains the decisive factor for the success of a machine vision solution. We at INSPECT are not overly unhappy about this, since this gives us the opportunity to present new and interesting topics to you in each new issue of our magazine. The issue in front of you will let you look into a whole lot of applications that were successfully solved with Vision Sensors and Smart Cameras. You´ll find these smart solutions in Turkey at the olive harvest, for code reading on glass bottles or measuring salt filling levels at one of the biggest and most efficient German salt suppliers.

Machine Vision in action can also be witnessed at some one of the upcoming trade shows during the next couple of weeks. For one there is the Hanover trade fair (20.–24.4) which will have to prove if it is for keeps also after some well-known companies canceled their presence for this year. Shortly afterwards, beginning of May, there will be the Control trade show in Stuttgart (5.–8.5.) with a much bigger focus on Machine Vision than in recent years. With the move from Sinsheim to the new fairground in Stuttgart the possibility to increase strategic topics has grown significantly. The Control show will be our main topic for the next issue of the INSPECT. The Laser trade show in Munich concludes the spring show series with emphasis on Machine Vision and Optical Metrology. At the Laser – World of Photonics (15.–18.06.) you will find quite some manufacturers for optical components presenting.

By the way: you are looking at our English language ePaper of the INSPECT. We started this service at the beginning of this year. Each issue of our well-known German language printed version magazine is provided to you with the same editorial content. Our worldwide readers already surpassed the number of 12,000. If your colleagues, business partners or friends are also interested in receiving our publication, have them contact us at contact@inspect-online.com.

And now, please enjoy the multitude of information in front of you.

Dr.-Ing. Peter Ebert

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Sensors Vision Sensors, Smart Cameras Vision Embedded Systems

The Pyramid's Wide Base

INSPECT Vendor Survey Vision Sensors, Smart Cameras and Embedded Systems

Machine Vision applications are often depicted in the form of a pyramid. The peak of the pyramid is the sophisticated customer or application specific vision system coming in small numbers at a high market price. The pyramid's wide base is constituted of vision sensors and smart cameras. The compact size, the economical price and the comparatively easy integration lead to high sales volume and increasing market penetration.

According to the EMVA (European Machine Vision Association) a Smart Camera encompasses also the compact vision system and is defined as follows:

"A camera with embedded intelligence, such as a microprocessor, DSP or FPGA, which can be programmed/parameterized. The Smart Camera can be used for different applications. The required application can be implemented by the end-user either by writing source-code or by parameterizing (e.g. with the help of a graphical user interface). Designs with a remote head are also included in this category. Typical characteristics are: compactness, fixed hardware-configuration and often based on embedded technology."

The Vision Sensor on the other hand is defined by the EMVA as:

"A turnkey product based on an image sensor combined with a processor unit integrated in a body and equipped with specific application software. Typically optics and lighting are already integrated. The application is destined for a specific task (e.g. code reading)."

This differentiation is done to allow a breakup between application specific products and generic, e.g. application independent, systems in the annual European market data survey that is executed by the EMVA.

According to this study European based companies sold globally in 2007 a number of 15,900 smart cameras at a cumulated revenue of € 24.4 million and a number of 15,800 vision sensors at a cumulated revenue of € 11.5 million. Compared to the previous year the number of vision sensors grew by 151%, the respective revenue grew by 40%.

The American Imaging Association (AIA), not distinguishing between smart cameras and vision sensors in their market study, determined an aggregated revenue of US$ 116 million in North America in 2007 and calculated a CAGR of 10,4% in revenue and 13,4% in numbers since 2003 with a size of the North American market back then at US$ 58,5 million.

Smart cameras and vision sensors make the fastest growing product group for machine vision. In this issue of the INSPECT you'll find out some of these reasons why that is so.

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www.rsb-optotechnik.de

Schmachtl
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Schunk
www.schunk.com

Sedeco Vision Components
www.sedeco.nl

Sensopart Industriesensorik
www.sensopart.de

Sensor to Image
www.sensor-to-image.de

Sharp Microelectronics Europe
www.sharpsme.com

Sick
www.sick.de

Sick IVP
www.sickivp.com

Siemens
www.siemens.de/simatic-sensors/
mv

SKS Vision Systems
www.visionsystems.fi

SmartRay
www.smartray.de

SmartSurv
www.smartsurv.de

Soliton
www.solitontech.com

Sony
www.sonybiz.net/vision

Stemmer Imaging
www.stemmer-imaging.com

Strampe Systemelektronik
www.strampe.de

Supercomputing Systems
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www.svs-vistek.com

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www.symco.co.jp

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www.scorpionvision.com

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(De)Centralization

Smart Cameras Are more than Only Stand-alone Systems

Both in independent companies and in big corporations you will not only find the intelligence at the company headquarters but also in the local subsidiaries and every single employee. They complete the work assigned to them and deliver results, or at least filtered intermediate data, to headquarters – an optimum and efficient function. Although this is common practice in the real world it is not always implemented in industrial image processing. The following article shows how this could be done more successfully with the aid of smart cameras.

© Flickr, Comala

Solutions for Every Image Processing Task

Matrix Vision offers a wide range of cameras with different bus systems. Even the USB 2.0 camera mvBlueFox offers a Hardware Real-Time Controller (HRTC) as an important feature, which makes time-critical I/O and acquisition control possible and therefore meets real-time demands. The smart cameras mvBlueCougar-P, mvBlueLynx and mvBlueLynx-M7 are equipped with a PowerPC CPU and Linux operating system. The mvBlueCougar-P is an industrial Gigabit Ethernet camera and combines the advantages of fast data transfers over long distances with those of a smart camera. In contrast to this, the mvBlueLynx camera is a representative of a complete, smart stand-alone system. For this reason the camera has all interfaces which are necessary for industrial usage. The mvBlueLynx-M7 module is the OEM alternative and allows connection of two identical sensor heads for stereoscopic applications or two sensors with different resolutions for mixed operations (e.g. for day and night operation). All smart cameras from Matrix Vision contain a standard operating system, combining the low cost of embedded solutions with the easy programmability of PC systems and, due to their open concept, they can be freely adapted. Additionally, there are enough sensors of different types available. Matrix Vision also offers solutions for the central evaluation unit. On the one hand, there is the mvXCell-8i accelerator board which upgrades PCs or servers with the PowerXCell multicore processor via PCI Express. On the other hand, there are IBM blade systems, which can also be equipped with frame grabbers. mvImpact software tools, a comprehensive image processing library for Machine Vision and image analysis, support the hardware and are available for different platforms.

Nowadays, smart cameras are considered stand-alone solutions which complete all inspection processes from the processing of data to the setting of control signals. However, there are many tasks that need, due to legal or quality specifications, the complete storage of production data, test results, etc. on a server (keyword: traceability). This also applies to PC-based solutions with standard analog or digital cameras. Consequently, a complete processing chain starts at the sensor and leads to a server.

▶ **The comprehensive product range of Matrix Vision offers components also for traditional machine vision solutions**

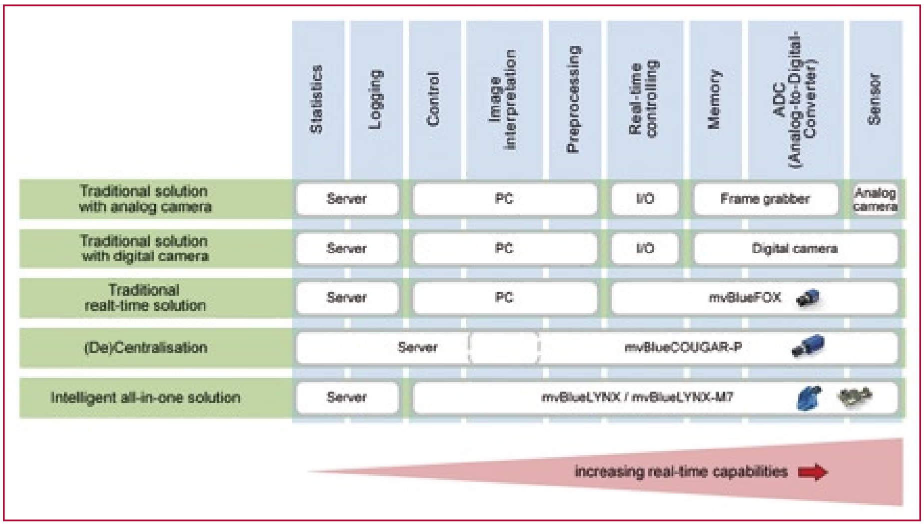
Factor Real-Time

The real-time requirements decrease constantly along the processing chain towards the server. In contrast, the sensor, its trigger and where necessary the pre-processing are capable of real-time. Nevertheless, not every application needs immediate inspection results to control ejectors or defect marker systems instantly. For surface inspection of webbed materials e.g., the detection of a defect suffices in many cases. The classification of the defect can be done later. As long as the machine vision system can create an exact time stamp and store the position of the incremental encoder, it will be possible to reconstruct the position of the defect later on. For the "pre-processing" part of the processing chain the demand for real-time capabilities could be dispensed with. It is important to find the point in the design of a machine vision system where the real-time capabilities are no longer essential. The earlier this position is in the processing chain, the simpler is the system.

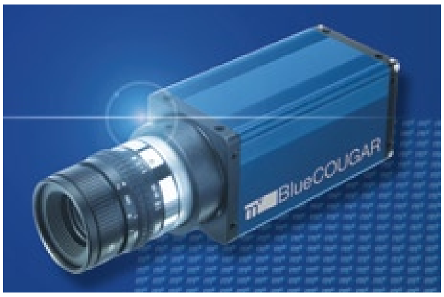
Current trends in digital cameras are moving towards bus systems like IEEE1394, USB and Gigabit Ethernet, which are not capable of real-time. If applications with digital cameras do require complex trigger and flash control, cameras with I/O and trigger inputs like the mvBlueFox may be used or separate I/O boards come into operation.

More Intelligence for the Camera

When using I/O boards some uncertainty due to the latency of the bus systems still persists. Is it therefore not more sensible to move the real-time relevant features into the camera and thus simplify the local system? An example for this would be the integration of a hardware real-time controller directly into the camera. But why stop there with the functionality of the camera? In much the same way, an image-dependent trigger, a time stamp generator or a scene-dependent flash control, for which the camera acquires several images with different flash times and chooses the image with the best illumination independently, could be integrated. Furthermore, the trend towards digital cameras leads to the accumulation of functions inside the camera. To come back to the example of the company: the less frequently a supervisor has to meet an employee, the more independently the latter can work. The more independently they operate, the more employees can be supervised at the same time. Similarly, a downstream PC can coordinate several image processing tasks, if cameras possess the necessary intelligence and meet the real-time demands independently.



Processing chain from sensor to server: the more components in-between, the bigger the friction loss



mvBlueCougar-P – a smart employee for Gigabit Ethernet applications

In addition to that, intelligence inside a camera offers more possibilities concerning "image interpretation" like triggering on certain image content, pre-sorting of images or the definition of areas of interest (AOI) to check only the relevant areas. The downstream PC or server receives only intermediate or final results. Thus, given that the resolutions of cameras increase, at the same time the data rate will be reduced, which in spite of ever increasing bandwidth remains an important point.

Improvements for the Server

Production plants with many cameras can concentrate their required PC power in server systems. This simplifies the maintainability and increases the reliability by using redundant processor blades, which take over the tasks of any failed processor unit automatically. The trend in the direction of multi-processor architectures can also be met by server systems. These servers are extremely powerful, easy to scale and can be placed in air-conditioned rooms, where IT expert staff can maintain them centrally. The environmental conditions of a PC system in a production line regarding temperature and splash water protection are usually considerably worse and, as a consequence, produce unnecessary expense.

Keys to Success

Smart cameras fit perfectly in the processing chain, even if they do not solve a complete task. A smart camera has to contain at least one set of real-time capable functions in order that a user benefits from the intelligence of a camera and the load on a downstream system is reduced. Ideally, a smart camera can be programmed freely so that it can be expanded with further application-specific functions. At the same time it should be possible to program without a large learning curve. Here, solutions which are based on Linux combine two essential qualities: first of all the programming and the conversion of existing algorithms in source can easily be done and secondly, as embedded systems, they are small, cost-saving and only require little resources.

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AIA Achievement Award to Toshi Hori

Toshi Hori, President of Gevicam, was presented with the Automated Imaging Association (AIA) Achievement Award during the AIA's 17th Annual Business Conference.

The AIA is the world's largest machine vision trade group and has over 300 member companies, world wide. It promotes machine vision markets by sponsoring trade shows, educational activities and the development and support of machine vision standards such as Camera Link and GigE Vision. The award recognizes Toshi Hori's direct contribution to the development and establishment of the CameraLink and GigE Vision standards for the AIA and also for his continuing leadership in the industry. In presenting the award, AIA Managing Director, Dana Whalls, expressed her appreciation for Toshi Hori's contributions and leadership to the industry.

www.gevicam.com

Online-tool to Calculate Cost Savings

Cognex announced the availability of a new online tool to help manufacturers understand the benefits that can be achieved through the use of machine vision and industrial identification. "In these difficult economic times, optimizing product quality and reducing manufacturing costs is more important than ever. Our new Cost Savings Advisor makes it really easy for manufacturers to calculate the cost reductions they can achieve through using Cognex vision and ID systems," says Peter Neve, Vice President of Global Marketing. The Cost Savings Advisor was designed to help customers evaluate a cost savings plan for vision inspection, automation or identification applications. Users are asked a few simple questions about each vision application. The tool then calculates the potential cost savings that could be achieved by implementing solutions on the customer's production lines.

www.cognex.com

90-Year Anniversary Erhardt+Leimer

It all started with a small shop established on February 19, 1919 by Manfred Erhardt for the repair and service of industrial clocks. Albert Leimer joined the company in 1923. In the 1920s and 1930s he transformed the company into a key supplier of measuring and control equipment for the local textile industry which, at that time, was still a major player in the area.

During the decades since the end of the war the company grew extensively and expanded its activities through an intelligent diversification and acquisition policy step by step to other sectors such as the paper, printing, tire, film and foil industries. The company's key competences today are in automation, visualization and inspection of all processes which occur in any web converting industry.

www.erhardt-leimer.com

20 Years Allied Vision Technologies

AVT, the manufacturer of digital cameras for industrial imaging is turning 20. On March 6, 1989, the company was founded as Manfred Sticksel CCD Kameratechnik in Alzenau, Germany. Founder Sticksel established himself within the German market as an importer and distributor of analog cameras and components for industrial imaging. Renamed Allied Vision Technologies in 2001, the company no longer has much in common with the firm of that time: it has evolved from being a distributor into a camera developer and manufacturer that has made a name for itself in digital technology. Headquartered in Stadtroda in the German Federal State of Thuringia, AVT today is one of the leading manufacturers worldwide of cameras for industrial imaging, now employing over 130 people at four locations in Germany, the US and Canada.

www.alliedvisiontec.com

Long Haul Technology

Point Grey Research (Point Grey) and Quantum Parametrics (QP) announced today an agreement whereby QP has been granted a license to market, sell and further develop Point Grey's proprietary FirePRO LDR IEEE-1394 Gigabit Ethernet (GigE) UTP Long Haul technology. The FirePRO LDR technology lets current and potential users of IEEE-1394 take advantage of 1000BASE-T (GigE) pulse amplitude modulation (PAM-5) signaling to achieve Gigabit transfers at distances up to 100 meters with CAT 5e, 6 or 7 cables at a fraction of the cost of optical fiber. QP plans to provide devices (QPLDR11) based on the FirePRO LDR technology to select customers this quarter, with a general release early in Q2. Devices will be offered in a 144-pin TQFP with plans to support a 132-ball csBGA later.

www.ptgrey.com
www.quantumparametrics.com

Navitar Expands

The company announced the recent sale of Navitar Coating Labs, located in Newport Beach, California. The decision was made to sell the coatings division based on the success of Navitar's recent acquisition of Special Optics, a Wharton, New Jersey firm, which has quadrupled the company's optical design capabilities and expanded the in-house optical coating capabilities. The company's growth began one year ago with the purchase of Special Optics, a firm specializing in the optical design and rapid prototyping of complete electro-optical systems. Additional optical design personnel were added at both the Special Optics facilities and Navitar's Rochester, New York headquarters.

www.navitar.com

Hexagon and Agie Charmilles Will Cooperate

Hexagon Metrology has finalized a significant collaboration agreement with GF Agie Charmilles. Under the terms of the commercial arrangement, Hexagon Metrology becomes the preferred measurement partner for the Swiss multinational. GF Agie Charmilles will now specify Hexagon Metrology coordinate measuring machines for all its 3D pre-setting and measurement applications. The agreement paves the way for the installation of Hexagon Metrology CMMs at the largest GF Agie Charmilles application centers in Geneva, Shanghai, Singapore and Chicago. GF Agie Charmilles will also showcase Hexagon Metrology technology at all the trade fairs at which it exhibits.

www.hexagonmetrology.com

Sarnoff Introduces First CMOS/CCD Image Sensor Testing System Based on EMVA-1288 Standard

Sarnoff Corporation announced the launch of Camera Commander, a complete CMOS and CCD imaging device and camera testing system for camera manufacturers and their users. Camera Commander is the first imaging testing system compliant with the European Machine Vision Association (EMVA) 1288 standard, enabling it to provide indisputable, internationally recognized test results. EMVA 1288 is emerging as the 'gold standard' for the machine vision industry. By relying on EMVA compliant tests, companies can rest assured that their imaging analysis data is absolutely accurate, reproducible and easily used for comparison of different imaging devices and cameras available.

Leveraging over 40 years of experience developing CMOS and CCD imaging device solutions, including the invention of TDI imaging and the multi-port CCD operation concept, Sarnoff's Camera Commander offers a compact system for efficient quality control of incoming and outgoing imaging products.

Camera Commander is comprised of a low-cost bundle that includes a computer, monitor, and software package for automated, high-speed inspection and analysis to assess product quality and to evaluate the appropriate component fit for a target application. Typically the test time of Camera Commander is less than 5 minutes per camera compared to the hours or days for equivalent testing with in-house methods.

Camera Commander's automated testing technology provides users with comprehensive analysis delivered in one easy to digest report. Using the EMVA 1288 testing standard, these reports provide an "apples to apples" comparison to various products on the market that are difficult to evaluate using testing systems built in-house.

"Manufacturers are under increasing pressure to improve quality control, but in doing so are continuously squeezed by cost and schedule pressures," said Mark Clifton, Vice President of Products and Services at Sarnoff Corporation. "Camera Commander allows them to quickly increase sensor quality with considerable cost and cycle time savings achieved through faster inspection time and an overall reduction in the number of returned goods."

www.sarnoffimaging.com

Everything Is in Motion

Checker Vision Sensor and Time Resolution

At the Vision show end of 2007, INSPECT hosted a panel discussion on the topic "All you ever wanted to know about Machine Vision software". One of the panelists, Cognex co-founder and Senior VP Bill Silver focused in his closing remark on motion and time resolution as the next most important development in machine vision software. INSPECT recently visited Bill at Cognex headquarters in Natick, Massachusetts and found out what this is all about and how it is connected to Cognex's vision sensor product Checker.

INSPECT: Bill, I heard you claim that the Checker is not only a vision sensor but a new technology unmatched in the industry. Isn't that a somewhat wild claim for the low cost end of the product range?

B. Silver: It's very easy to look at Checker as Cognex's low cost easy to use vision system. You know, we took In-Sight, which is more expensive and does a million things and wanted something that was easier and cheaper, so we stripped out all this stuff and now all Checker has is a couple of simple tools, and its really easy to set up. Well of course that's the truth but it's not the whole truth. And the whole truth is, I think, more interesting. I think it really does represent a tremendous break from the past and one that – if I have anything to say about it – is going to be much more common in machine vision moving forward.

"I remember I gave a paper in 1984 for a conference in Boston on why grey level processing is a good idea."

Regarding the break from the past, I remember you saying during the panel discussion we had in Stuttgart that there are two important technology developments coming up: one is 3D, and the other one is time resolution. So over a year later now, would you still forecast the same?

B. Silver: I would. So let me talk some about motion and time resolution, partly because I did make that probably the centerpiece of my closing remarks. I think it was probably the most surprising thing that people heard that day because nobody else was talking about it. I'm the only one, and here's why. Let's go back 25 years to the emergence of industrial machine vision. So, in the old days, all image analysis and industrial machine vision was binary. Threshold an image, and you've got a binary image and you do things like blob analysis and morphology, and that's the way it was all done. Grey levels were kind of controversial. I remember I gave a paper in 1984 for a conference in Boston on why grey level processing is a good idea. And there were articles saying it's a waste of time, who needs all these grey levels because after all it's either an object or its background. And what my paper showed, that it makes a difference even if the object is essentially binary, like let's say a character. It's supposed to be binary. It's either ink or not ink, right? But here's the problem and this problem is fundamental to machine vision accuracy, and one of the reasons I'm interested in motion today. You've got a pixel grid and if you've got a perfectly binary object its edge cuts through the pixel grid in random ways. That's why you need the grey levels, because if you want to get down to the sub-pixel level you've got to understand how these edges cut through the pixel grid. And the pixel grid fundamentally limits what you can do. In the early days, it was very controversial that you could get any sub-pixel accuracy. In fact there are some people even today who are skeptic, "You can't get sub-pixel, that violates the sampling theorem. How can you get more resolution than your pixel size?" Well of course in 1983 people didn't believe it. There were articles published in the trade press saying this whole sub-pixel thing is nonsense. Just like you were talking about the 40th of a pixel, was it just a myth…

"The grid is the limiting factor for things like normalized correlation."

It's a long way from binary images to the claim of sub-pixel accuracy of a 40th of a pixel.

"You don't have to squeeze that same orange any more because now you've got fundamentally new information that you didn't have from that one image."

B. Silver: We eventually had to prove that you really could do it, and the key was going from binary to grayscale. That was the key to sub-pixel resolution. And the reason is you need more information. When you have a binary image you've kind of thrown away all this information and the nature of the pixel grid is what kind of screws it up. So we went to grey levels, and we achieved sub-pixel resolution. The problem though with grey levels once again when we developed things like Search is that the patterns we were looking for with the search were represented by pixel grids, alright. So if you look at a correlation template even if it's grayscale it's represented by a pixel grid. With pixel grids it's easy to move one pixel by one pixel or five pixels. It's hard to move a pixel grid by 2.5 pixels or 3.7 pixels, it's hard to rotate a grid. When you rotate a grid, when you change the magnification of a grid, when you scale it, errors are introduced necessarily, and again the grid is the limiting factor for things like normalized correlation. So when we went to PatMax, what I call geometric pattern matching, the idea was to get away from the grid representation.

By using a camera you have no chance but starting off with a pixel grid.

B. Silver: Of course you have to start off with a grid because that's what the camera does, But if you can represent your model not as a grid, but as essentially a geometric shape that is at least conceptually real numbers then all of a sudden you can rotate it, you can do all sorts of things without losing accuracy, and that's why with these methods we were able to get more accuracy than correlation. We can argue about whether it's a 40th of a pixel. I'd be happy to have that discussion as to why I believe that, but that was the next step.

Now at this point, sub-pixeling long since solved, what is the next step, what is the next "PatMax"?

B. Silver: You know what? We have gotten as much information out of an image as we are going to get. We are not going to get anymore information out of an image. And here is the reason why I say this: when we went from binary to grey level and developed Search grey level normalized correlation it took us about three months to make that work. It was 10,000 lines of code. Some very clever algorithms were developed, and that got us from whole pixel accuracy to quarter pixel or whatever it is. PatMax was probably 100,000 lines of code and it took four years.

We are squeezing information out of that image and squeezing and squeezing and squeezing information out of the image and you know what? It's gone man. To get more information out of the image than PatMax gets, would take a million lines of code and 10 years and who knows whether it would really even work. It's like you ever squeeze an orange to get orange juice? At some point you stop and throw the orange away because the effort to get another drop of juice out of that orange isn't worth it. And I think that's where we are with images today.

"To get more information out of the image than PatMax gets, would take a million lines of code and 10 years and who knows whether it would really even work."

So, how do you get more information, what do you do?

B. Silver: To me what you got to do is get past the limitations of the pixel grid, and these accidental alignments that I keep talking about. For every image, all the image features are aligned relative to the pixel-grid in an accidental way. Where was that object when the trigger came in? So here's the thing about motion. Motion eliminates accidental alignment because you can see a feature as it moves through the pixel grid. It will appear in one image in a certain way relative to the pixel grid, but the next image it will be moved a little bit, it will be rotated a little bit. So you get to see it multiple times. You get to see that feature as it cuts this pixel grid in different ways and all of a sudden it's like opening up a window, there's more information. You don't have to squeeze that same orange any more because now you've got fundamentally new information that you didn't have from that one image. You can watch this feature move through the image. To give you an example, let's say that I'm running a standard edge detector. I've got an edge that's a little bit under resolved. It's maybe a pixel wide, or maybe a pixel and a half. As this thing moves through the pixel grid, as this thing rotates, the basic characters of that edge – its strength, its direction, whether it even exists or not – change quite a bit based upon the accident of where it hit that pixel grid. And if you look at these algorithms you can see what happens when things get a little bit under resolved. The fundamental measures vary quite a bit. It's no longer reliable whether this edge exists, you can no longer tell where exactly it is anymore from a single image. But, from several images if you can identify that feature in these several images as Checker tries to do, – all of a sudden you can recover a tremendous amount of information. Accurate information about where it is, accurate information about whether it exists or not, accurate information about its angle.

Checker was the starting point for the use of new methods to get beyond the pixel grid?

"Checker is right now the first and only product on the market that does motion."

B. Silver: The methods I've been working on since Checker are to use the motion of objects through the pixel grid to fundamentally get additional and more reliable and more accurate information about everything from edges to complex patterns. And to me, if you want to do better than PatMax, if you want to take the next step, you've got to get more information and motion is one of the best ways I know to get that information. Everything is in motion – in an industry, in the world, everything is. Even if something stops in front of the camera it had to move to get there. So if the information is available in the process all you've got to do is build the sensors and the algorithms that can take advantage of it. And if you want to do better than what we've got now from a single image – to me that's one of the best ways of doing it. 3D is another way of getting additional information but again we have squeezed that one image as much as it's going to be squeezed. You got to do something different. And the reason I'm excited about motion is – as I said – everything is in motion, I don't have to create it, it's already there. The quality of the information you get, the accuracy and reliability of information that you can get goes up tremendously. I also like it because nobody else is working on it. I like things that nobody else is doing. Checker is right now the first and only product on the market that does motion.

Why is it that this method is only used in the lowest cost and easiest product of Cognex, and not in any other product so far?

B. Silver: Historical accident.

Ok, ...

B. Silver: A lot of times the answer to the why questions is, it was an accident. Checker was a giant accident. We really were trying to make a low cost easy to use vision system. That was the original goal of the project and so we said „Ok, we need a low cost imager". What we also need since it's a vision system, is an imager with a global shutter. The problem was to find an imager with a global shutter that's cheap. Well cheap means CMOS. At that time, you could get plenty of CCD sensors with global shutters but they were very expensive and we were having a hard time finding what we wanted. Well, one of the hardware guys came up to me and said "I've found this sensor. It's very inexpensive, it's got a global shutter, but I'm sure you're not going to like it. I only brought it up because it's the only one I could find with a global shutter and is inexpensive. But the reason you're not going to like it Bill, is because it's only 128 x 100 and that's not enough". So I looked at it and I said, „Yeah that's really not a whole lot of pixels, but – oh isn't this interesting, it runs at 500 frames per second. What can you do with that?" Well immediately it occurred to me that no one else was thinking about what you could do with it. That's what gets me interested, what is it that no one else is thinking about. Now maybe they're not thinking about it because it's a stupid idea, but I was intrigued by this and I said „Well, is there anything you can do with 128 x 100 pixels in machine vision?" And it occurred to me that we compete with photoelectric sensors for inspection applications where people use five or six sensors to inspect something. Photoelectric sensors got one pixel. Surely with 13,000 pixels I can do something. I've got 13,000 times as many pixels as that guy does. Now I don't have a quarter of a million pixels like In-Sight does, but surely there's room in the world for a 13,000 pixel sensor, when we know that one pixel sensors are useful. And I also said to myself „Why should I make yet another quarter of a million pixel sensor?" The world is covered with quarter of a million pixel sensors. So, this accident got us to thinking – what can you do with this oddball thing that's only 13,000 pixels, but runs at 500 frames a second? That's why it's in Checker and not anything else. It was this kind of accident.

"Everything is in motion – in an industry, in the world, everything is."

"The only way to get something radically new is to start over again."

So the major innovation needed the open mindset for starters.

B. Silver: At that point the In-Sight project has been going on for 10 years. Major innovations like this never happen to a mature product line. Technology is like cement. When cement is wet you can do anything – it's early, it's new, you can pour it into any shape you want but once it dries you're stuck with it and technology is like that. When you start off with the technology you can mold it any way you want but after a certain amount of time, and particularly when it starts finding some success in the marketplace, it becomes hard like cement. You can no longer do big things to it. You can chip away a little bit at it, but the only way to get something radically new is to start over again. And of course with Insight, you're not going to do that. Its 10 years old. It's wildly successful. It's a great product. So it had to be something new. It's the history of how the technology was developed that determined why it ended up in Checker and not somewhere else.

Bill, it was fun talking to you and I'll be looking forward to the next historical accident that you might come up with.

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The 23rd Control is right on course

In order to get right to the point and make a straightforward statement: The 23rd Control international trade fair for quality assurance is developing splendidly and, together with the exhibitors, is once again taking advantage of the current crisis as an opportunity. If we look back at the history of Control for a period of roughly 20 years, it becomes plainly apparent that the trade fair, and thus its clientele as well, have emerged with renewed vigour from the economic downturns of the last two decades. And thus Control can rightfully claim to play an important role as a driving economic force by consistently implementing the maxim pursued by trade fair promoter Paul E. Schall, namely the creation of "trade fairs for markets."

Control-Organizer Paul E. Schall: „Also in difficult times, the Control is a reliable dimension."

The current figures speak for themselves. At the end of February, more than 800 manufacturers and suppliers from 24 countries had already registered, and enquiries for further booth floor space are still coming in. Many companies recognise the fact that they are better able to assert themselves in economically difficult times with improved quality, and thus more production efficiency. In other words: Quality is always in demand. Above all, when it's coupled with beneficial innovation and greater efficiency, and provides users with an immediate competitive advantage.

Strictly speaking and to put it point blank, the 23rd Control international trade fair for quality assurance is truly phenomenal: Many exhibitors booked floor space immediately after Control 2008, and at the beginning of the year, after a short period of reflection, there was another thrust which still continues in a very lively fashion. This is an indication of the strength, the stamina, the willingness to accept responsibility and the belief of QA industry companies from inside and outside of Germany in their own capabilities.

They know they're in good hands with Control, and the time tested trade fair team. And the 23rd Control won't just offer innovation with regard to the incorporation of QA topics which are relevant to the entire process sequence; the trade fair promoter is also providing substantial support in the area of expert visitor canvassing and promotional marketing activities. These include visitor coupons which can be ordered by the exhibitors in large quantities in order to address their target groups directly, press activities involving trade journals and daily media, broad-based ad campaigns in both foreign and domestic trade publications, as well as Internet activities and free advertising materials for the exhibitors, making it easy for them to invite customers and other interested parties to Stuttgart by means of concerted action.

Finally, Control presents itself as an "old faithful" for manufacturers, suppliers and expert visitors in difficult times, during which a reference point for orientation is extremely important and trust must be re-established. As in the past, quality remains a benchmark for global competition, and must therefore be seen as a key to sustainable success both today and tomorrow.

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Hopes Are High for Automatica 2010

The preparations for Automatica 2010 are in full swing, because the international leading trade fair for automation and mechatronics, that is taking place from 8 to 11 June 2010 at the New Munich Trade Fair Centre, wants to follow on from its previous successes. And the signs are good, because times of crisis are always also times when structures and processes are improved – an ideal field for automation and Automatica. This fair will be presenting innovative and integrated solutions for every technical manufacturing challenge.

Around 15 months before the start of the next Automatica, over 20,000 m^2 of exhibition space (net), about two thirds of the entire exhibition area in 2008, is already booked. More than 260 high-ranking exhibitors have said they will be participating in the International Trade Fair for Automation and Mechatronics, which focuses on assembly and handling technology, robotics, machine vision and associated technologies. All the leading manufacturers of industrial robots, such as ABB Automation, Fanuc Robotics, Kuka Roboter, Motoman and Reis Robotics will be there.

Components and Solutions to Optimize Processes

A plus point for Automatica is the clear exhibition spectrum that was developed in close cooperation with the robotics and automation industry. The key technologies of assembly and handling, robotics and machine vision form the core areas. Automatica thus represents the entire spectrum of automation and forms complete value-added chains – from the components to the system, and from the application to the services. Despite its diversity Automatica is a compact fair with a clear layout; the halls are arranged thematically so that every visitor can quickly find their way around.

Anyone looking for tailor-made automation solutions will strike gold at the fair. As well as the latest trends and innovations it offers specific solutions that further optimize production processes. Arne Lakeit, Head of Planning at Audi AG emphasizes, "With its wide product range Automatica provides a good platform for Audi as a systems user. We can discuss solutions here with our suppliers efficiently and completely in keeping with 'Vorsprung durch Technik' - from single components to the application of complete systems."
And Peter Keppler, Marketing Director System Solutions, Stemmer Imaging GmbH, Germany is convinced. "For us linking machine vision and robotics is particularly important. When talking to our visitors we have noticed that Automatica's concept of linking the assembly, robotics and vision industries makes complete sense to them. Automatica is ideal for end customers looking for an actual solution."

Top-class Visitors

Automatica 2010 is taking place in Munich, in the heart of the largest European market for robotics and automation. As a European hub this location combines internationalism and centrality in an ideal way so that the entire automation community – suppliers and customers from all over the world – can come together over the period that the fair is taking place.
The trade fair is aimed at users and developers of automation components and systems – from conglomerates and small and medium businesses to start-up companies. Particularly in difficult times, automation should be a key topic for every sector, whether automotive (OEMs/suppliers), mechanical and plant engineering, the metalworking industry, electrotechnology and electronics or, for example, pharmaceuticals, cosmetics, medical, packaging and plastics.

Robotics Convention on Topics from Science and Practice

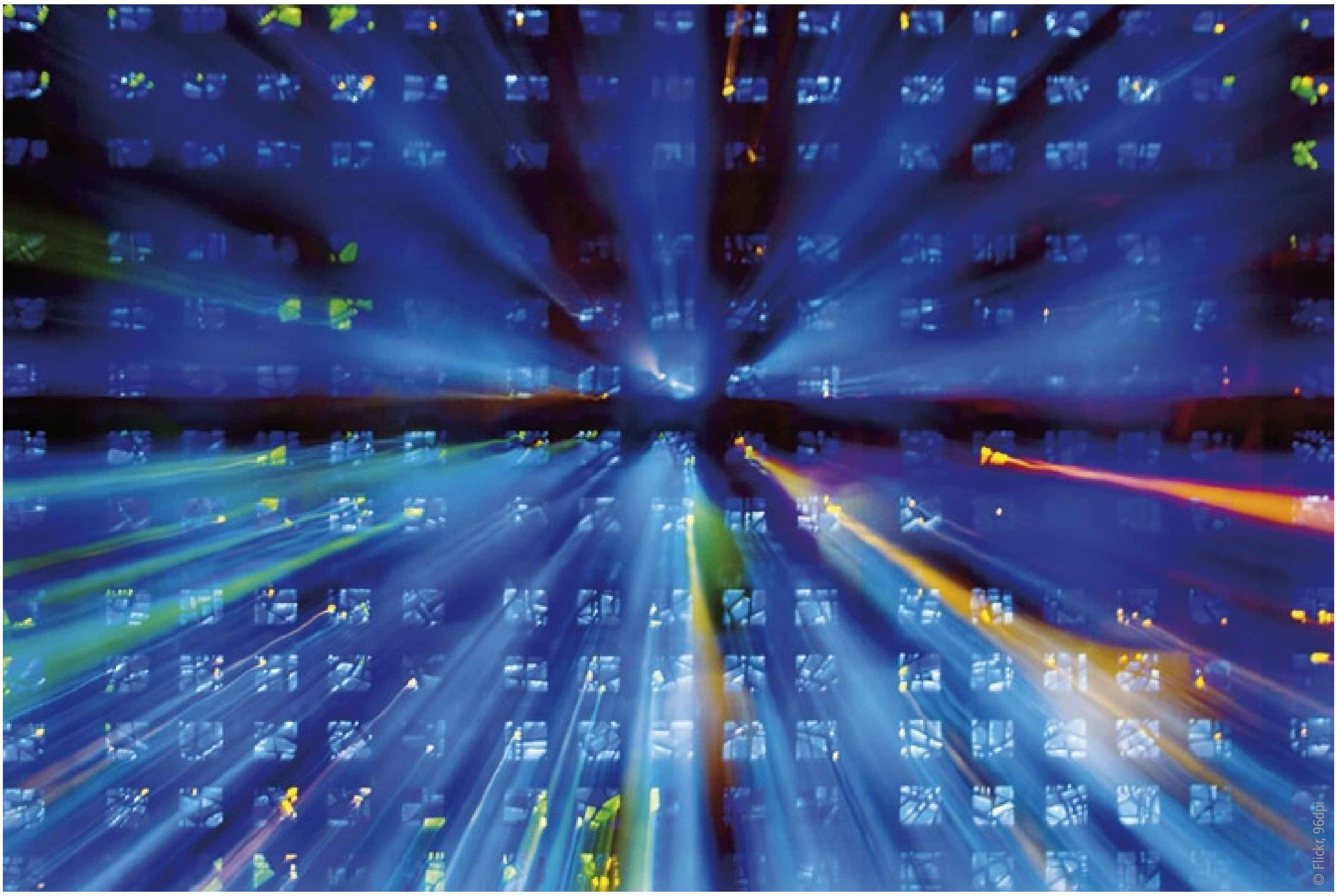
The national and international visitors are also eagerly awaiting the International Symposium on Robotics (ISR). This is seen as the biggest robotics convention in the world and will take place in 2010 in the International Congress Centre Munich (ICM) in parallel with the German Robotics Conference. Behind the co-branding of ISR 2010/Robotik 2010 is an integrated event with a joint program committee, starting on Monday, June 7, and continuing for another two days in parallel with Automatica. People attending the convention will also receive a ticket to the trade fair. The 300 or so participants expected from Germany and abroad will be brought up to date with and exchange information on the latest developments, trends and applications in robotics. Conceptual sponsors of the event are the Deutsche Gesellschaft für Robotik (DGR – German Society for Robotics) and the Robotics + Automation Manufacturers' Association within the VDMA, Germany's engineering federation.

First-class Accompanying Program

To give innovations and solutions as much space as possible, Automatica 2010 is also supported by a first-class accompanying program. Once again in 2010 the 'Service robotics innovation platform' is an integral part of Automatica, in which leading robot manufacturers, suppliers and research institutes from Europe and overseas will jointly present the very latest in international service robotics. Christoph Schaeffer, organizer and stand manager for Fraunhofer IPA, commented, "We have only just started roughly planning the 2010 stand and we are already getting enquiries from exhibitors wanting to make sure they secure an advantageous position on the 40 m^2 service robotics community stand."
Mechatronics, as a future technology, is once again an important element of Automatica 2010. As an integral part of modern assembly technology and intelligent robotics, mechatronics makes mechanical engineering a safe investment and also attracts government investment incentives. So Automatica will highlight the many aspects of this topic.
The Automatica forum is another highlight for trade show visitors. Subjects that promise real additional benefits to the 'normal' stand visits are tackled in panel discussions and talks. The diverse program focuses on innovative automotive topics in a practical and solution-oriented way, covering all user sectors.
www.automatica-munich.com

Fan of Rays

Optical Metrology Basics: Spectral Sensors



A spectral sensor is a miniaturized spectrometer equipped with a detector array. The spectrometer spreads the incoming bunch of rays according to wavelengths, and the detector array captures the complete spectrum simultaneously during the exposure time. Spectral sensors thus provide detailed access to the spectral information of the incoming radiation. This article describes some of the optical principles of spectral sensors.

The linear dimensions of a typical miniature spectrometer (see fig. 1) are in the range of some centimeters. Versions with Si-photodiode-arrays or CCD-arrays are available for the spectral range from 250 nm to 1,100 nm. The NIR-range from 900 nm to 1,700 nm is covered by InGaAs-detectors. Spectral sensors usually are designed for a spectral bandwidth (resolution) of about 10 nm. Some companies have focused on a rugged design and offer spectral sensors optimized with respect to compactness, stability and the requirements of mass production. Miniature spectrometers are mature components and well suited as spectral sensors for industrial applications such as colour measurements or inspection of thin films in the production line. They may even be used in harsh environments like in mining or precision farming [1].

Fig. 1: Spectral sensor with dimensions 7 x 6 x 4 cm³ incl. front-end electronics
(Photo: Carl Zeiss MicroImaging GmbH)

Concepts

The system elements of spectral sensors are the optical input for pick-up of radiation from a target or a light source, the miniature spectrometer, which spreads the incoming radiation according to its wavelength distribution along a small strip in the dispersion plane, a linear detector array, and the front-end electronics. Two different configurations are in use for the spectrometer component, the so-called Czerny-Turner mount with a plane grating and a modified Rowland-circle mount with a spherical grating [2]. For both designs, a small entrance slit is illuminated with the radiation sampled by the optical input. The Czerny-Turner mount, shown schematically in figure 2, images the entrance slit to infinity by means of a spherical mirror, thus producing a bundle of parallel rays which illuminates a plane grating. Diffraction produces different bundles of parallel rays emerging from the grating under different angles, each angle depending upon the wavelength of the radiation within this bundle. A second spherical mirror focuses these bundles to different points in the dispersion plane. The spectral distribution is thus transformed to a distribution of intensities along a line, which can be picked-up by a detector array. Such a design basically is a miniaturized optical bench with discrete optical components. A typical entrance slit has a width of 100 µm, the length of a spectrum is about some millimetres. This concept has been employed by Ocean Optics, e.g., for their miniature spectrometers. The alternative approach, depicted in figure 3, is based on a concave grating, which combines focusing and diffraction within a single optical component. The intention of the optical design is to allow for a very long entrance slit and to image this slit very precisely to a flat strip in the dispersion plane [3, 4]. Such imaging, aberration-corrected flat-field gratings are a masterpiece of technical optics and are produced with holographic methods. Typical representatives of this technique are the miniature spectrometers from Zeiss or Jobin-Yvon. Some designs, the so-called monolithic spectrometers, are based on a rigid block of glass with a curved backside, where the grating is embossed.

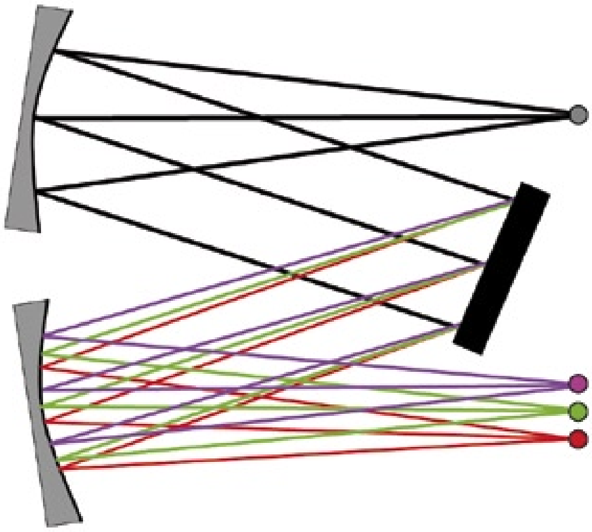


Fig. 2: The Czerny-Turner-mount with a plane grating in parallel light

Pros and Cons

The footprint of a spectral sensor is substantially determined by the dimensions of the detector array and the front-end electronics. Thus, the optical design usually is tailored to the pixel-pitch and the dimensions of an available detector array. The concept of the optical bench with discreet elements can utilize simple optical components, but proper mounting and adjustment require much care and effort. The monolithic concept with the spherical grating in a massive block of glass is promising with regard to stability and robustness. It requires a special optical element, but has a single reflecting surface and can handle a very long entrance slit, resulting in high efficiency for

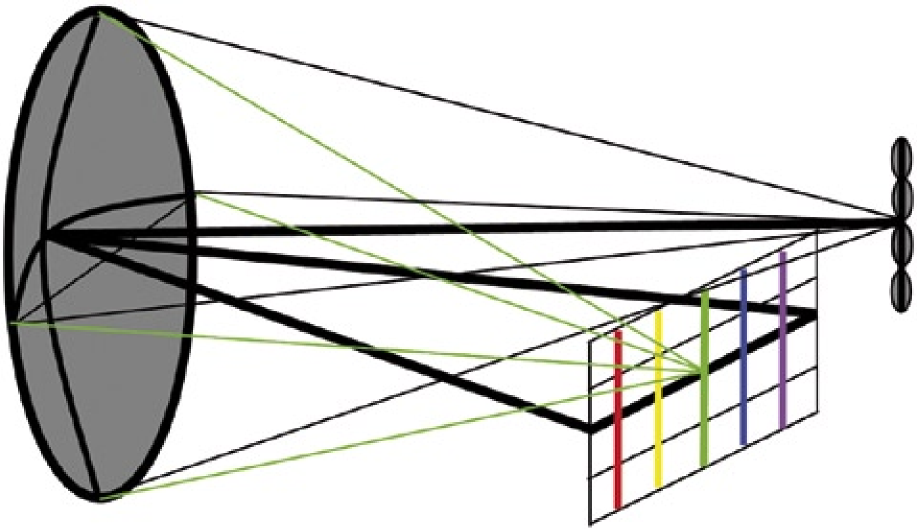


Fig. 3: A concave imaging grating produces images of the long rectangular entrance slit in the focal plane, separated according to their wavelength

pick-up and throughput of the radiation emitted by a target or a light source.

The optical input for spectral sensors usually is a fibre-optical element. Simple sensors use a single fibre with an effective diameter of typically 100 µm. The output of the fibre is directly used as the entrance slit. The magnification often is about 1, resulting in an image of the fibre with a diameter of about 100 µm on the detector under ideal conditions. This diameter sets the lower limit for the spectral bandwidth of the system, since the optical parameters of the grating determine the relationship between the scaling in the dispersion plane and the wavelength-scale. The corresponding figure of merit is the linear dispersion, which might have a value of 150 nm/mm, e.g., resulting in a bandwidth of 15 nm for the system mentioned above, where the diameter of the image of the entrance slit in the focal plane of the spectrometer is 100 µm. The bandwidth usually is sampled with 3 or 4 pixels of the detector. Oversampling would result in lower signals in the pixels, but not in a better bandwidth. Undersampling, however, would not fully exploit the optical bandwidth with the detector signal and would result in a deterioration of the resolution of the sensor. The minimum diameter of the image of the entrance slit on the detector depends upon the width of the entrance slit and upon the optical properties of the grating and the other imaging components. The optical elements and the dimensions of the entrance slit thus must be carefully tailored to the geometry of the detector. Spectral sensors with aberration-corrected optical elements can handle not only circular, but also long rectangular entrance slits. For this purpose, several single fibres are used for the optical input, which are mounted in a straight line as the entrance slit or integrated in a cross-section converter. The Zeiss MMS-1, e.g., uses a cross-section converter from a circular fibre-bundle with a diameter of 0.5 mm as the input and a rectangular slit with a width of 70 µm and a height of 2,500 µm as the output. This device utilizes the 15-fold optical input area compared to a simple 100 µm-fibre. The pixels of the detector array of the MMS-1 have a width of 25 µm and a height of 2,500 µm and are well suited for this geometry.

The dispersion along the detector array is not necessarily constant. The pixel scale thus has to be calibrated with well-known wavelengths to establish a proper transformation of pixel coordinates to the wavelength scale. The remaining uncertainty may be important for some applications. For industrial applications, the thermal drift of the wavelength scale sometimes is a critical parameter. When high dynamic range is the most important requirement, like in chemometrics, the stray light level may be not negligible. Stray light may produce pseudo-signals in some regions of the spectrum or can contribute to a diffuse background in the signal. Therefore, it is a good idea to pick up radiation from those parts of the spectrum only which are within the specified spectral range of the spectrometer. For the same reason, it may be helpful to restrict the wavelength range to a single octave, like between 380 nm and 760 nm or between 500 nm and 1000 nm and so on, to avoid the problems originating from signals due to diffraction into higher orders [2]. The optical performance of the spectrometer is an important issue, but the properties of the detector array and the front-end electronics have a huge influence upon the quality of the signal of the spectral sensor. The effective dynamic range, the sensitivity and the signal-noise-ratio may be much more important for certain applications than the spectral bandwidth. These parameters will usually vary as function of the wavelength and may thereby determine the effective spectral range of the sensor, even when the miniature spectrometer is optically well suited for a larger spectral range.

Conclusion

Spectral sensors are devices for the measurement of the spectral distribution of radiation. Their key optical element is a miniaturized spectrometer. They are designed for a spectral bandwidth of about 10 nm and are well suited, when compactness and robustness are more important than spectral bandwidth. Spectrometers with similar optical data may well be quite different with regard to signal quality, like dynamic range or noise, depending upon the type of detector array or the performance of the front-end electronics. The figures of merit for spectral sensors are complex concepts. For a comparison of spectral sensors from different sources, the underlying definitions and the methods used for the determination of theses figures should be carefully examined.

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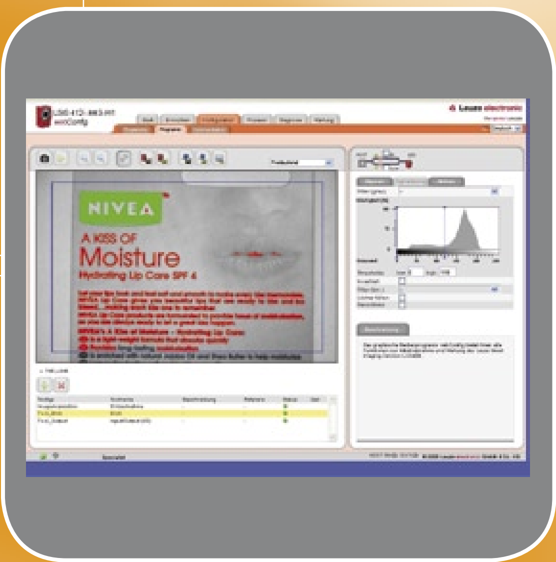
Inspect

Vision



INNOVATIVE HIGH-PERFORMANCE CAMERA TECHNOLOGY BY LEUZE ELECTRONIC

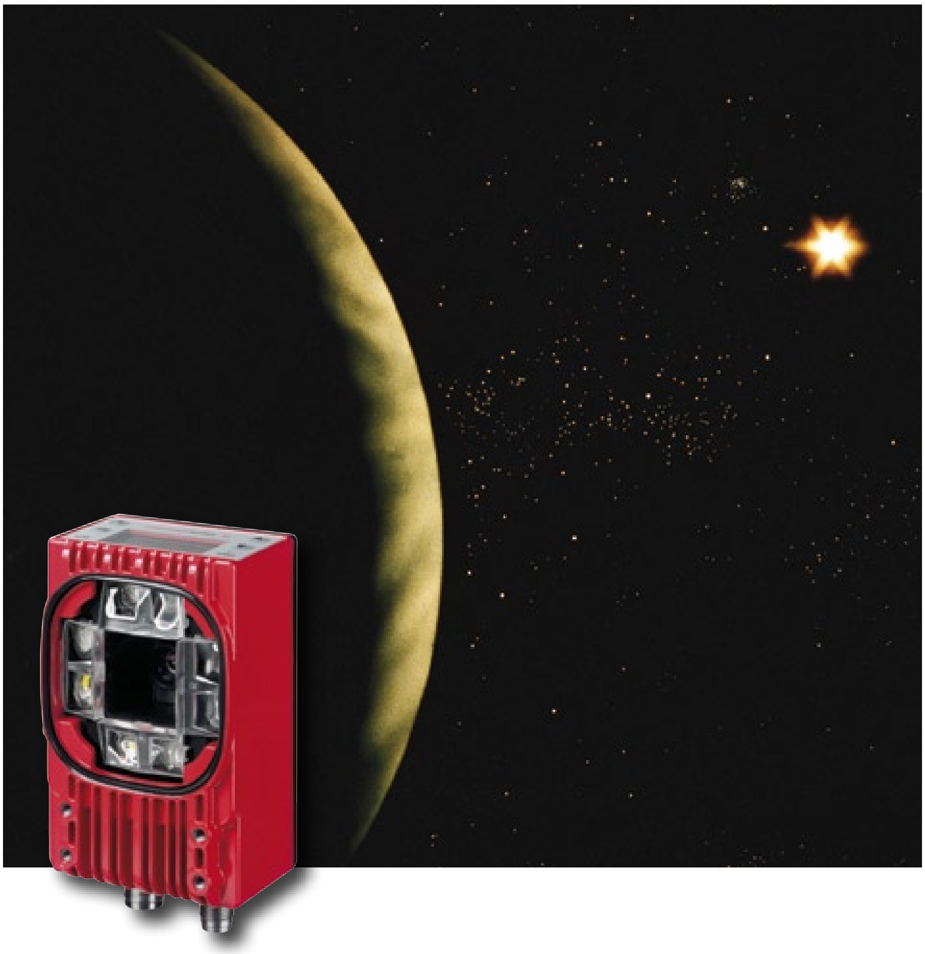
Leuze electronic has been an active player in the image processing field for more than 10 years. With knowledge accumulated during this time and in countless applications, the specialists for optical sensors have developed a new high-performance smart camera, the new LSIS 400i series. It distinguishes itself with its flexibility, wide application range and high process reliability.

More on Page 20

Smart Cameras of the Next Generation

Innovation Focus on User Needs

Optical sensors specialist Leuze electronic has been active in the area of machine vision for over a decade. Based on the know-how acquired over this time and in numerous applications, a new high-performance series of smart cameras characterized by unique features such as web configuration, motor-driven focus adjustment, homogeneous light design and a particularly powerful blob analysis was now developed. These features simplify integration for the user, offer flexibility in the application and enable a wide usage spectrum as well as high process reliability.



In recent years various device classes, differing in flexibility and subsequent cost of integration, have established themselves for applications in machine vision, a key technology within the automation sector. PC- or controller-based vision systems are at the peak of the performance spectrum. For the majority of automation tasks, however, vision sensors – or the more-powerful, faster and flexible smart cameras – are the better choice. They can be integrated quickly and at lower cost, yet offer flexibility and performance that is sufficient for many applications. In this market segment, the new LSIS 400i series developed by Leuze electronic represents the smart camera of the next generation.

In the User's Focus

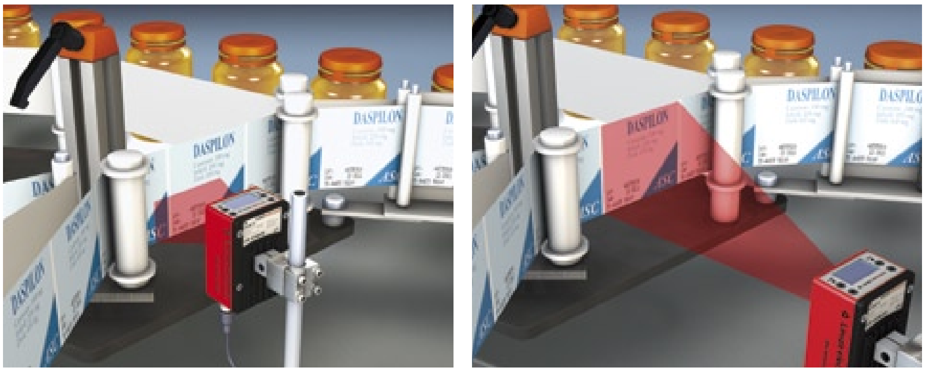
The user of machine vision knows that the focus of a vision application is not only on the processing performance or the embedded algorithms, but that the decisive factors for the success of the implementation encompass illumination, flexibility in camera adjustment and costs associated with integration. This includes mounting and alignment options as well as easy operation.

As a performance-determining element the illumination is among the most important qualitative features of such systems. Here very often LEDs are used which are normally arranged in a ring shape, whereby each individual LED emits its light at a specific angle. The light pattern is naturally round in shape: characteristically dark on the inside with an intensity that, at first, increases strongly to the outside and then again decreases with increasing distance from the center. Furthermore, the round light spot stands in contrast to the rectangular camera chip. The inevitable result of such an arrangement is a relatively inhomogeneous illumination which, in the end, affects the quality of the image analysis.

At least just as relevant to quality for a vision system and the achievable gauging and inspection results is focusing. A wide range of solutions is available here, ranging from interchangeable to adjustable objectives. Most of these require manual access in applications that are often located in constrained spaces. As a result, exact focusing is associated with difficult alignment and is often difficult to reproduce.

Not obviously relevant to quality, yet always in the user's focus, is the handling of the smart camera. This involves, above all, the configuration, which generally is executed via a dedicated software program installed on a PC. And which service technician and which maintenance engineer has not yet had the painful experience that exactly this PC is not accessible when urgently needed.

On lot changes, the new check routine is loaded with the focus setting for the specific camera distance. By means of the motor-driven focus adjustment, the device moves to the appropriate focus position, i.e. no manual focusing is necessary on the device



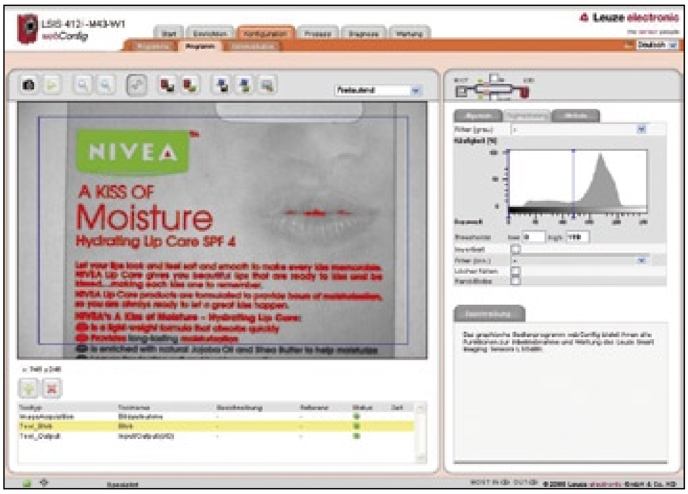
Compared with conventional LED illumination, the image acquired by the LSIS 400i series is considerably more homogenous and more detailed. This results in better, faster and more reliable image processing results.

Full of Innovations

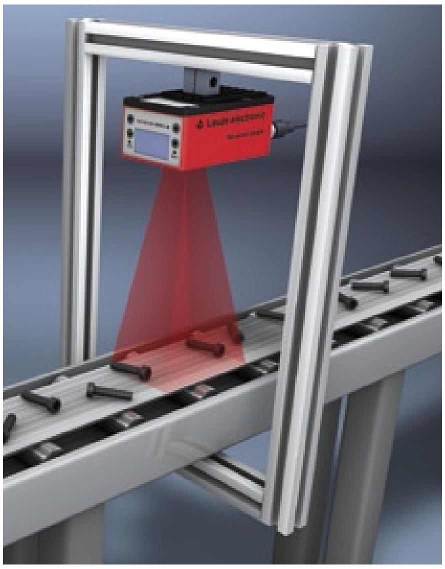
Leuze electronic has taken these as well as many other requirements into account and incorporated them in the development of the new LSIS 400i smart camera series. This new series is full of high-performing innovations. The fact that the development incorporated extensive application know-how is apparent even externally in the industrial-suited appearance with a robust metal housing. A glass window, sealed airtight in accordance with protection class IP 65, protects the camera technology and the illumination system integrated behind the glass. Instead of using standard LEDs, Leuze developed an illumination system with special optics. It consists of eight rectangular segments fitted with precisely calculated, free-form shapes. As a result, each of the segments generates an extremely homogeneous, rectangular light pattern that is particularly intense in the range from 50–250 mm.

Not noticeable at first glance, but of decisive importance for the flexibility and, thus, attainable quality, is the motor-driven focus adjustment. On lot changes with different object distances, this saves the user the need to perform manual focusing. The new check routine is loaded with the focus setting for the specific camera distance. The motor-driven focus adjustment moves the lens to the corresponding focus position. An innovation that facilitates reproducible adjustments as well as improvements in quality and, particularly in applications with restricted installation space, one that results in a noticeable simplification.

Another new feature, and one that considerably eases use of the smart camera, is the integrated webConfig configuration interface. Developed by Leuze and first used in the BCL 500i barcode readers as configuration software, this program enables device configuration directly via a web browser. With the LSIS 400i, however, performance goes greatly beyond that of a configuration tool. Here, the entire image processing software is integrated in the device. An Ethernet interface provides fast and easy access to



The parameterization software does not need to be installed on the user's PC. It is ‚on board', and can be accessed with any web browser.



With the high-performance blob analysis of the LSIS 410i, a wide range of tasks in completeness and presence inspections as well as in position detection can be performed easily and reliably

the device for simple integration. The software does not need to be installed on the user's PC. It is ‚on board', and can be accessed with any web browser. Should servicing be necessary, this means that the complete configuration software as well as an online help system, are available on-site within the device – at all times and wherever it may be located.

Software Competence

A key factor for the performance of the new LSIS 400i series is the blob analysis implemented by Leuze electronic. Blob stands for binary large object and is a common and well-proven method of image processing. It identifies a continuous area of pixels in an image. By making use of blob features, such as area and circumference, individual objects or object groups can be specifically detected. An area is the summation of the pixels enclosed in a blob, optionally including any holes within the blob. The circumference is the length in pixels of the outer contour of a blob. The new LSIS 400i can check for considerably more properties, however. For example, the ratio between area and circumference of a blob can be used to determine a shape factor that classifies its geometric appearance. Furthermore, by checking the major and minor axes of a blob, the rotational position of an object can be determined. With the high-performance blob analysis, this new generation of smart cameras can simply and reliably perform a wide range of tasks in completeness and presence inspections as well as in position detection.

Production-oriented

Innovations such as the illumination system developed by Leuze electronic or motor-driven focus adjustment, satisfy the highest demands in reliability, efficiency and flexibility. With its integrated webConfig configuration interface, Leuze electronic demonstrates user-oriented development know-how that considerably simplifies device integration and operation. Also worth mentioning in this context is the bilingual display on the device for simple diagnostics and status displays, the integrated connectivity with Ethernet and RS 232 interfaces – with eight digital, configurable inputs and outputs – and the intelligent fastening concept with M12 connection technology.

The smart camera series LSIS 400i will be available the upcoming summer 2009.

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Real-time Immersive Experiences

Optical MotionTracker for AR and VR Applications

Imagine being able to tour the Magna Leptis, one of the biggest and best preserved Roman cities in North Africa, from the comfort of your own home, or tour a new construction project before it has even been built. These ideas have formed the basis for a growing number of commercially available augmented reality (AR) and virtual reality (VR) applications. A necessary requirement for augmented and virtual reality applications is the real-time tracking of human users and artifacts in the environment using optical measurement technologies. The goal of these technologies is to calculate the exact pose (position and orientation) of a tool, object or person within a pre-defined coordinate system.

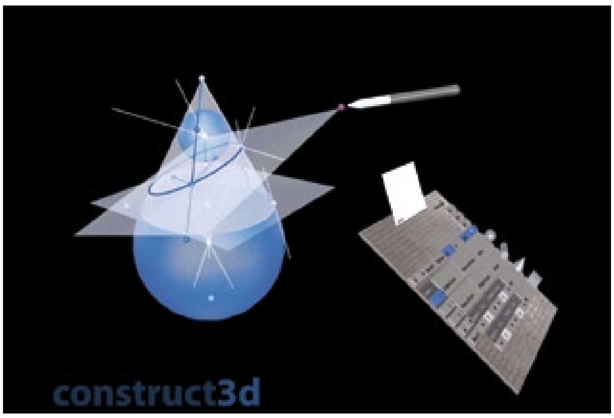
While the cost of computing, projection and display components has decreased dramatically over the last decade, the cost of motion tracking components has not. Frustrated by this fact, and motivated by their vision of making immersive VR applications more affordable and thus accessible to broader audiences, a small team of researchers around Dr. Hannes Kaufmann from the Vienna University of Technology's Interactive Media Systems Group began to design their own low-cost, easy-to-use motion tracking system. In 2007 they launched iotracker (www.iotracker.com), a line of products designed to provide users with an affordable infrared optical tracking solution that meets the stringent requirements of real-time 6-DOF motion tracking of immersive visualization systems.

Move through Virtual Reality

Optical motion trackers typically use multiple two-dimensional imaging sensors (cameras) to detect „active" infrared-emitting or „passive" retro-reflective markers affixed to some interaction device. The iotracker system is comprised of up to eight small calibrated infrared cameras with integrated infrared (IR) strobe lights, one synchronization unit, a PC workstation running the iotracker software and several rigid-body targets attached to various interaction devices. Based on the information received from multiple cameras, the system is able to calculate the location of every marker through geometric triangulation. When more than two markers are grouped together to form a rigid-body target, it becomes possible to determine the target's orientation, yielding a total of six degrees of freedom (6-DOF). In a simple example, this allows a user to interact with a virtual environment, "moving" themselves or an object left/right, forward/backward, and up/down.

Calibration in Three Steps

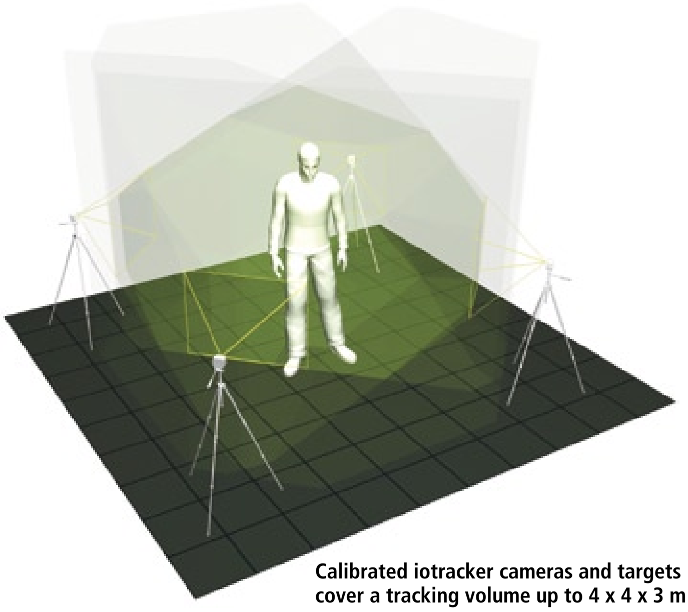
The cameras and targets used in the iotracker system must first go through three separate calibration steps to achieve accurate triangulation. The first



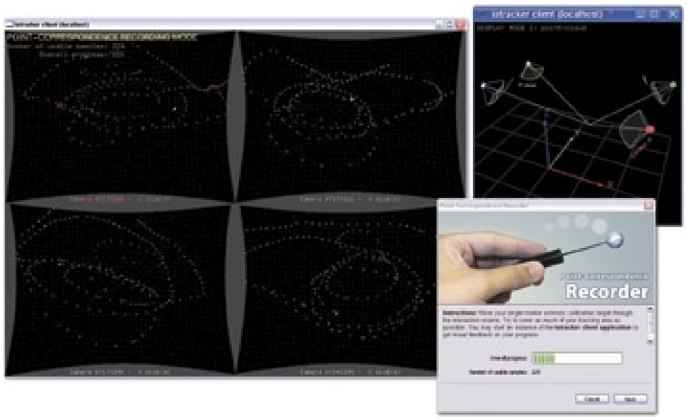
Optical motion tracking plays a key part in immersive visualization experiences is known as “intrinsic calibration”, which compensates for image distortion due to the camera optics and is performed by iotracker technicians prior to shipment. “Extrinsic calibration” is performed in-field by the user, and is the process of finding the spatial transformation – where they are positioned relative to one another –between all pairs of cameras in a given setup. Extrinsic calibration must be repeated every time a camera is moved or reoriented, but takes only a few minutes to complete. The final step is to train the system to recognize the rigid-body targets. This process is called rigid-body target calibration. Once fully calibrated, the iotracker system can deliver sub-millimeter precision and below 5 mm accuracy (RMS) of point-measurements throughout the entire tracking volume.

Affordable and Accurate Cameras

For image capture, iotracker uses Firefly MV IEEE 1394a digital camera modules from Point Grey Research. The compact board-level Firefly MV cameras are integrated with a control board in a custom created camera enclosure that measures just 71 x 66 x 40 mm. The housing unites the camera and an IR LED array, creating a powerful image generator. The camera’s 3.6 mm focal length M12 microlens and wide angle IR emitters can achieve a 90-degree diagonal field of view, which allows the system to cover a maximum tracking volume of up to 40 m³. The Firefly MV is equipped with a wide-VGA 1/3” global shutter monochrome CMOS sensor from Micron (www.micron.com) that has near-IR capability in the 850 nm range. The near-IR performance of the sensor allows shorter shutter times, which minimizes motion blur, a common problem in fast motion capture systems.



Calibrated iotracker cameras and targets cover a tracking volume up to 4 x 4 x 3 m



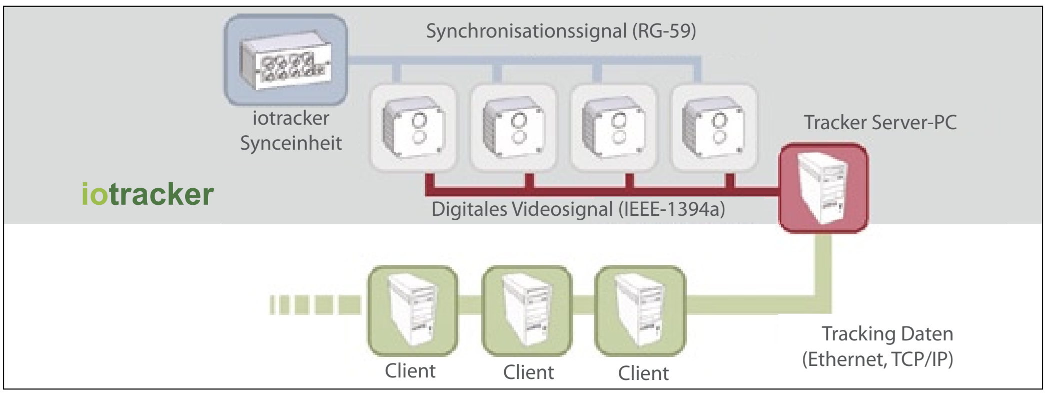
iotracker graphical user interface for in-field camera calibration

“Point Grey is well known in the academic community for its affordable machine vision and stereoscopic imaging products, and we worked extensively with their products at the Vienna University,” says Thomas Pintaric, Core Developer at iotracker. “We ultimately selected the Firefly MV for a number of reasons. It’s the most affordable IIDC v1.31-compliant camera model on the market, and unlike similarly priced IIDC v1.04-compliant cameras, the Firefly MV supports external triggering, which we use to accurately synchronize shutters from multiple cameras.”

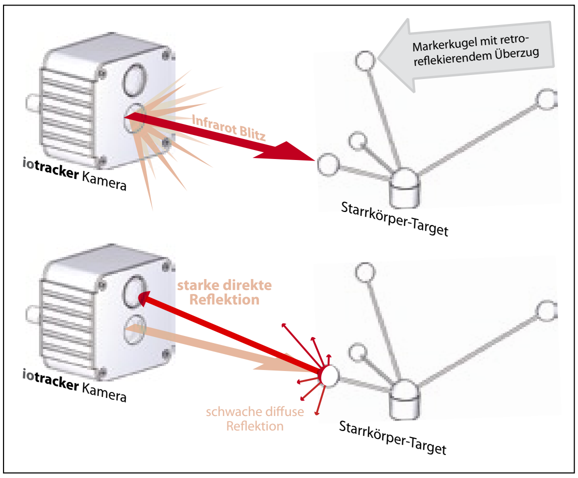
High Speed 3D Location Detection

The iotracker system uses passive rigid-body targets composed of retro-reflective spherical markers. The target designs are computationally optimized for maximal tracking performance and minimal self-occlusion, are constructed using lightweight carbon-fiber and polyamide materials, and have an industrial-grade (EN 471 Class 2) retro-reflective marker coating. The markers‘ special coating reflects most of the infrared light emitted by an iotracker camera back to the imaging sensor. iotracker cameras can be wall or tripod-mounted, and are shutter-synchronized to a trigger pulse signal sent out by the iotracker synchronization unit over a BNC coaxial cable. Every camera streams digital video at 60 FPS to the tracking workstation via IEEE 1394a (400 Mbit/s FireWire). “The possibility to operate two Firefly MV cameras on the same IEEE-1394a bus at their maximum frame rate by using a custom image size of 608 x 480 pixels made life much easier for us,” adds Pintaric, “because it enabled us to connect a larger amount of cameras to the same workstation.”

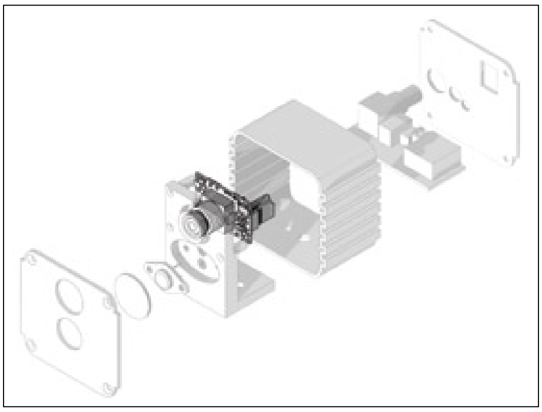
The cameras send a continuous stream of images to the tracking workstation, where the iotracker software runs advanced image processing



Compact iotracker camera housing integrates board-level FireWire camera and IR strobe lights



Rigid-body targets reflect IR light emitted by an iotracker camera back to the image sensor



iotracker system overview

algorithms in real-time to calculate the projected centers of every marker in every camera image. The 3D location of every marker is recovered via geometric triangulation. The software identifies pre-calibrated rigid-body targets and computes their position and orientation. It then transmits the resulting 6-DOF measurements to subscribed client machines over a TCP/IP Ethernet network. The high frame rate of the cameras and the speed of the iotracker software results in a very low latency of between 18 and 40 ms, depending on number of tracked rigid-body targets. The software also provides support for a wide range of third-party software packages, such as a built-in Virtual Reality Peripheral Network (VRPN) device server, which allows VRPN-aware client applications to directly stream tracking data from the server machine over TCP/IP.

"The modular design of iotracker allows users to customize and configure a tracking system for their specific needs," says Dr. Zsolt Szalavari, Product Manager for iotracker's distributor Imagination Computer Services. "The high precision, large tracking volume and easy and flexible setup of the system make it perfectly usable for many application areas like VR/AR research, architectural walkthroughs, engineering decision-making and real-time motion capture. It is also the first truly affordable optical motion tracking system that gives you the full benefit of high-precision motion tracking while keeping an eye on the budget."

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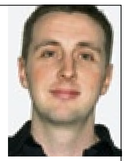

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Distortion-free Rendering

The History of Telecentrics

It is an often-told opinion that telecentrics were a recent invention, having been introduced with the development of industrial imaging. This is not so. The phenomenon of telecentrics exists from the day where man began to experiment with lenses and to produce optical systems from them. However, telecentrics as such was defined only in the 19th century.

Telescopes

The first telescopic systems are telecentric. Their focal length is infinite, and their lateral magnification is given by V = y'/y.

Galileo Galilei, who, in 1609, built his Dutch telescope, is named frequently as the inventor of the telescope. The original telescope, however, is presumed to have been built a year before by the Dutchman Jan Lippershey. Galilei improved on this system to attain a magnification of about 33. Even though, Galilei was the first to scan the sky systematically, discovering the four largest moons of Jupiter, which were given the name of Galileian Moons. Kepler, on the other hand, only theoretically calculated his astronomical telescope, and it was built only in 1613 by an optician named Scheiner. In contrast to Galilei's telescope it had the drawback of giving an upside-down image.

Microscopes

The first microscopes did not yet yield a particularly good image quality, and, in addition to that, certain effects could not be explained by geometrical optics. It fell to Ernst Abbe in 1880 to formulate pertaining physical laws and end building microscope by trial-and-error. From then on, the resolution of microscopes was no longer limited by the material used, but by the physical laws of refraction, the lower limit of which being called Abbe´s limit. Amongst his discoveries was the desirability of a telecentric ray path for measuring microscopes and projectors. This allows compensating for a slightly varying object distance and for any non-congruence of measuring line and image plane by a telecentric design of the ray path on both sides. Abbe is thus one of the first to use the term telecentrics to describe a parallel ray path.

Profile Projection

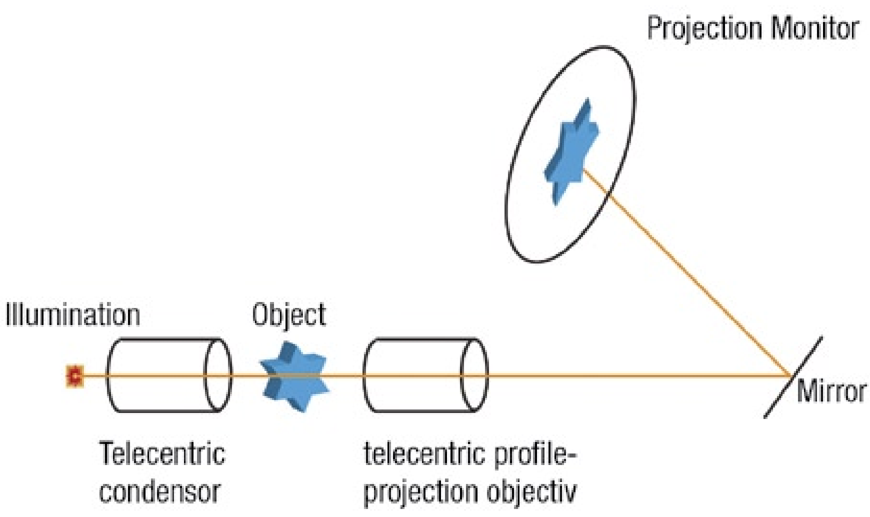
The introduction of serial production required further development of metrology, to guarantee exchangeability of components. This led, in about 1920, to the first application of telecentrics for purposes of technical inspection and measuring of components. It was used with optical profile projectors that required both a telecentric condenser for lighting and a telecentric lens for imaging. Since about 1970, Sill Optics has been manufacturing exactly such telecentric lenses and the appropriate condensers for telecentric lighting purposes. The principle of profile projectors consists of projecting an enlarged image of a component placed on a slide onto a screen. Later on, the projecting screen was equipped with a graduation for a better determination of quality and of the degree of inaccuracy. Even the development of telecentric lenses for imaging did not render profile projection completely obsolete. Particularly in countries with an emerging industrialization, these instruments are favored for their ruggedness and easy operation. In fact, Sill Optics today is the only remaining manufacturer of profile projection optical systems for screens of all sizes.

Telecentric Lenses

The development of cameras for industrial imaging and continuously rising quality control demands required thinking of new inspection methods. For that reason, several companies were experimenting, in the 1990s, with telecentric lenses for industrial imaging and were marketing them shortly afterwards. In the beginning, these lenses were little more than an entocentric (i.e. normal) lens of a certain focal length, in front of which a front lens attachment was placed. Quality of the image varied greatly, depending on the grade of the front lens and its position within the system. These lenses also showed a high degree of distortion and inferior color correction.

Further rising demands on accuracy were no longer met by these optical systems, and thus one proceeded to calculate complete systems by means of optical-design programs.

Today, Sill Optics manufactures telecentric lenses of all types. Depending on requirements, there are lenses with telecentric properties on the side of the object, or of the image, or on both sides; these are available for all kinds of sensors. In addition, there is a choice of different classes of quality with varying numerical aperture and distortion.



Ray path through a profile projector

Applying Telecentric Lenses

Today's applications of telecentric lenses can be found in most fields. One of the foremost is object-side telecentrics, which is used for measuring and perspective-free imaging of bores, pins and of moving objects.

Less known is telecentrics on the image side. Here, the lens functions as an entocentric lens of a certain focal length. On the side of the image only parallel rays will be created which will then hit the screen. This is of advantage when working with sensors carrying micro lens arrays. Image-side telecentrics will avoid shading effects that can arise by the rays not hitting the lens perpendicularly. These lenses are also well suited for measurements of homogeneity of light sources, or for beamer projection. Telecentrics on both sides combines the advantages of both principles. Also, on account of the symmetric optical arrangement, there will be no geometric aberration, as for example distortion. A further advantage is that unsharpness increases symmetrically and that thus objects remain measurable. Lenses with telecentrics on both sides will be used frequently with line scan cameras and when high measuring accuracy counts.

In closing, one can say that telecentrics constitutes an important milestone in further developing industrial imaging.

Telecentric lenses by Sill Optics

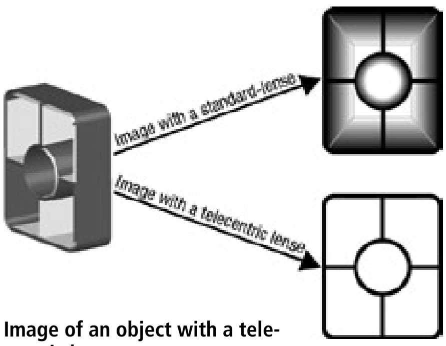


Image of an object with a telecentric lens

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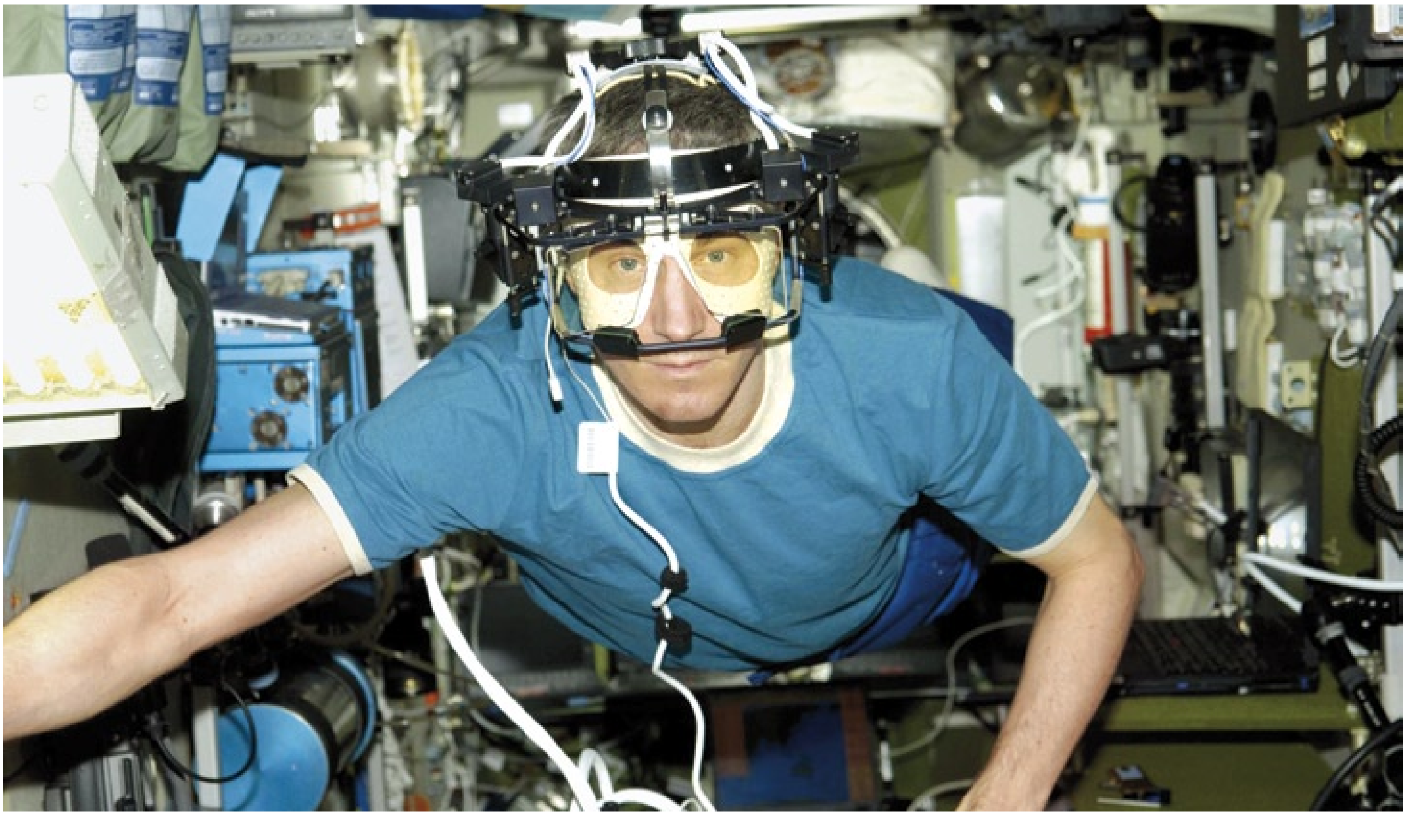
Eyes Wide Open for Innovation

Smart Cameras for Real-time Image Analysis



Do innovations need time or can they be achieved in the wink of an eye? Both is true for the Berlin based vision company Chronos Vision. Their "Eye Tracking Device" has been in use onboard the International Space Station since 2004.

The head-mounted device records and measures eye movements at up to 400 frames per second, and with a spatial resolution that records even the smallest of shift in eye position. The image processing technology is based on CMOS sensors, which permit both high performance and compact size. In addition to the deployment of the space-qualified model, a more standard version of the Chronos Eye Tracker has been installed in numerous neuroscience and ophthalmologic research laboratories worldwide. The Chronos technology has also found application in other areas such as the expanding field of laser surgery.

Eye tracking plays an essential role in modern systems used for refractive eye surgery. The improved spatial and temporal measurement performance provided by the Eye Tracker has led to substantially more refined methods in this field of eye surgery. Throughout such eye operations it is imperative that the surgeon is able to track the position of the eye with micrometer precision. Accordingly, the control of the operation laser beam is constantly corrected by the co-ordinates of the eye as measured by the Eye Tracker. Modern surgical lasers are typically clocked at 400 ablations per second. For this reason it is not only necessary to measure eye position at this rate, but also to keep the processing time of the image analysis to a minimum. To this end the Chronos Eye Tracker delivers eye co-ordinates with a latency of 2 ms. "This brings two improvements for the surgeon, who can program his laser sequences more precisely and reduce the duration of the operation," explaines Dr. Baartz, CEO of Chronos Vision. Since its introduction a few years ago, this technology has been installed in hundreds of Lasik operation systems.

Desk model of the Chronos Vision OneKPlus Eye Tracker

Currently Chronos Vision is introducing an even faster Eye Tracker to the market – the so-called OneKPlus Eye Tracker, which as the name suggests is capable of analyzing 1,000 frames per second and beyond. Here again, real-time image analysis is exploited to provide both high sampling rates and short latency times, enabling high speed, real-time control, for example of the surgical laser. With this new technology Chronos Vision achieves a latency time of 1 ms. Combined with the high spatial resolution in the range of micrometers this represents a major contribution to the development of the next new generation of laser surgical systems. High precision, real-time measurement of eye position is also of acute interest in the field of neuroscience where new techniques for synchronized recording and analysis of brain activity and eye movement are revealing more information on the sensorimotor and visual systems.

In order to achieve this level of performance in image processing Chronos Vision exploits the Smart-Sensor technology of the Ranger camera series by Sick/IVP. The current Ranger camera employs a sensor chip with a 1,536 x 512 pixel array, combined with a parallel processing architecture based on one ADC and one RISC processor for each of the 1,536 pixel columns. This massive, on-chip parallel processor architecture opens up the field for the development of any number of innovative and – above all- fast algorithms. The eye-tracking algorithm is one good example. By programming the sensor on so-called multi-sensor mode, high-speed online image analysis with synchronous transfer of grey-level images of the eyes is possible. Thus, the co-ordinates and radius of the pupil are output to the host computer in quasi-real-time (1ms latency), while the grey-level image sequence is transmitted via the Gigabit Ethernet interface of the camera. A further advantage of the Ranger camera for eye tracking is provided by the three to one aspect ratio of the sensor area, which permits recording of both eyes on one and the same sensor. This offers the advantage of simplified synchronous recording and reduces hardware complexity and costs. This is of particular interest in the neuro-opthalmologic research and clinical diagnosis where analysis of binocular eye movements is required.

Chronos Vision

Chronos Vision GmbH was founded in 1998 by the vestibular researcher Prof. Dr. Andrew H. Clarke, Head of the Vestibular Research Lab at the Charité Medical School in Berlin and the physicist Dr. Friedrich-J. Baartz, and is situated in Focus Mediport in Berlin-Steglitz.

Currently the company is active in two main areas. The first of these is industrial machine vision with a focus on high speed systems providing up to 30,000 images per second. This approach is increasingly of interest for system integrators and OEM companies, who are developing real-time 3D quality control systems. As a Premium Partner of Sick AG, Chronos Vision provides professional support to these customers in the efficient deployment of the Sick/IVP machine vision products.

Chronos Vision's second field of activity is the development of high quality eye tracking equipment for use in scientific research and medical diagnosis.

The experience and competence in machine vision design and development accumulated by Chronos Vision over the years puts them in a position to provide professional expertise to their customers in both industry and science.

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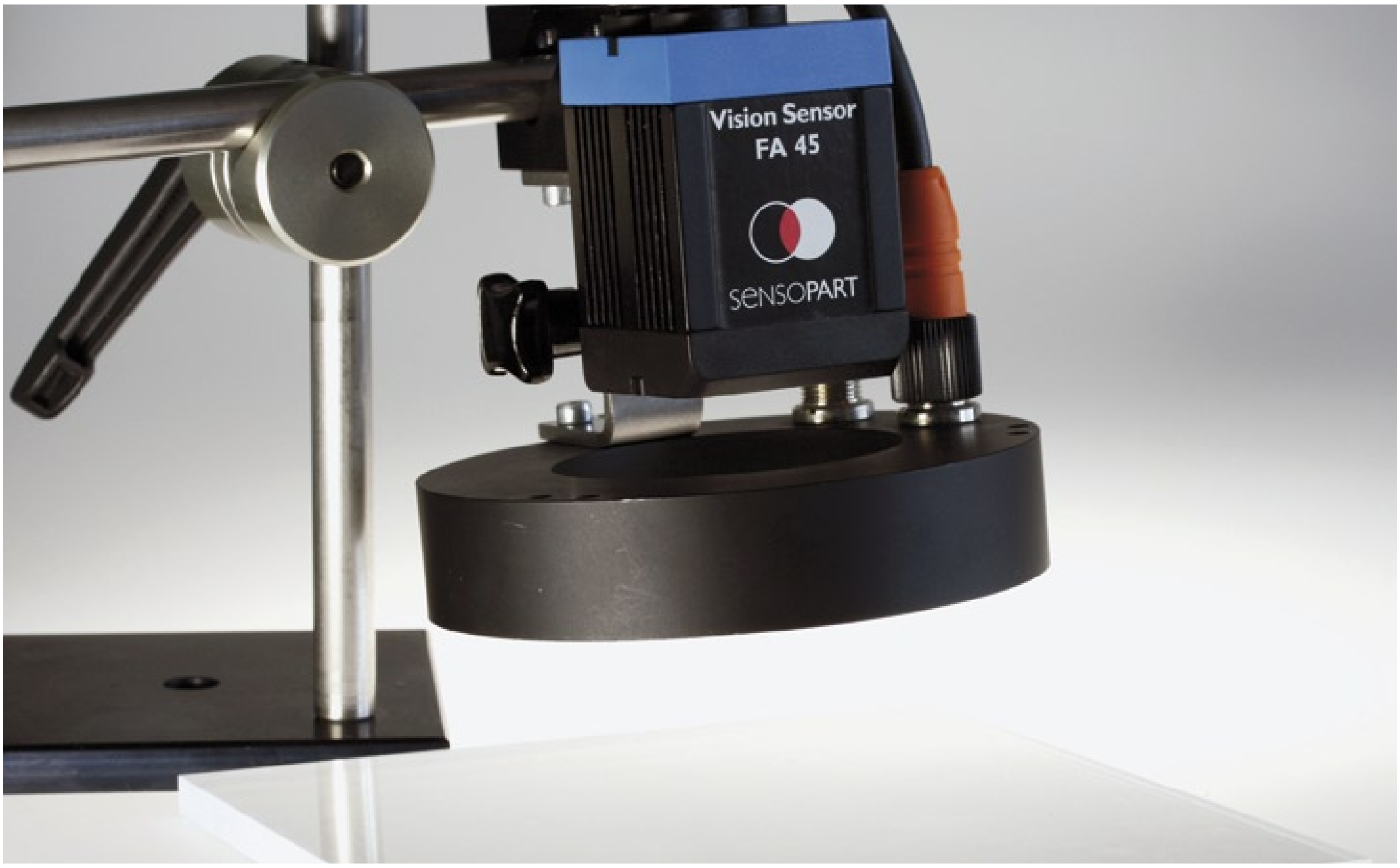
Getting the Lighting Right Is Half the Battle

Vision Sensor Reads DataMatrix Codes on Reflecting Glass Plates



With the use of vision sensors, lighting is what it's all about for a stable and reliable process function. The more so with a demanding application like reading DataMatrix codes. With a code reader variation of their FA45 vision sensor, SensoPart Industriesensorik now realized an application that represented a particular challenge in that respect: error-free decoding of DataMatrix codes applied on reflecting plates of glass.

SensoPart received this enquiry from the engineering works of Gerold, a company located in the Lower Rhine area of Germany, manufacturing machinery for the production of solar modules. During production, coated glass plates are stacked and de-stacked and have to be identified by laser-written DataMatrix codes. For this, the end-user was looking for a reliable automated solution: "100% recognition rate," was the customer's prerequisite. SensoPart proposed using a code reader variation of their FA45 vision sensor. In order to be able to guarantee reliable reading of the codes on the highly reflecting glass plates, the optimum arrangement of sensor and lighting was established in a field test (fig. 1)

Eliminating Reflections and Double-contours

To detect characteristics on a reflecting surface, the so-called dark-field lighting principle is chosen. Here the sensor is tilted by a certain angle off the perpendicular, so that the light emitted by the sensor and reflected by the object will not be returned directly into the sensor (fig. 2a/b). But in this case the solution of the problem was not that simple: "When detecting raised or grooved structures on transparent objects this arrangement will not yield satisfying results," says Markus Koslik, SensoPart Product Manager, "because interference between reflections from the mirrored front and back of the plates will cause double contours." Here, such a grooved structure was encountered in the shape of the laser-written codes. Using specimens supplied by the end-user, SensoPart therefore carried out trials with both sidewise-arranged area light and torus-shaped light (fig. 1, 2 c/d). To avoid double-contours the FA45 has to be positioned exactly at a right angle to the glass plate. It turned out that with the given measuring distance of 120 mm a lighting angle of 45° yielded the best results (fig. 3). For cost reasons the end-user decided on using the area-lighting variation (red light).

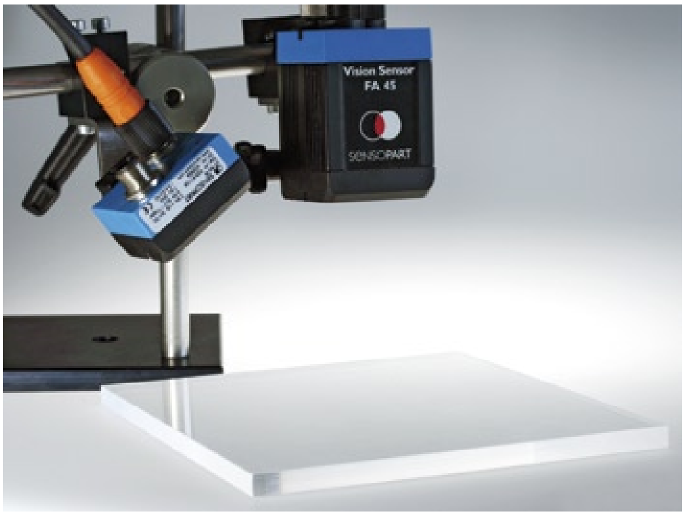


Fig. 1: Field testing lighting variations: Frontal arrangement of the FA45 vision sensor and 45°lighting. Both area light (left) and torus light (right) yielded equally good results

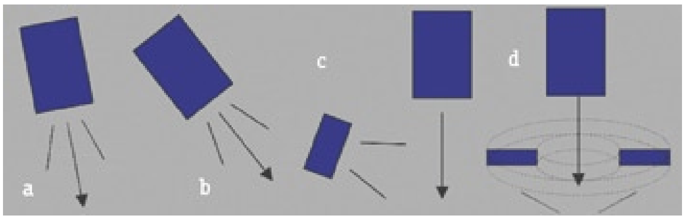


Fig. 2: Dark-field arrangements with integrated sensor lighting (a, b) pose problems with transparent objects, as double contours may occur. To avoid these, frontal alignment of the sensor, combined with an external light source casting light from the side, is recommended (c, d)

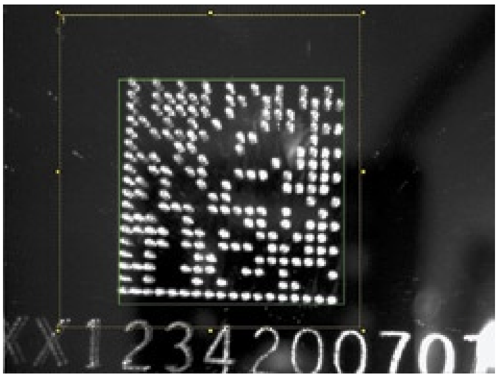


Fig 3: Glass plate with laser-written ECC200 code as seen through the FA45's lens. The arrangement chosen, with, respectively, area or torus lighting will largely suppress double contours

High Reading Reliability

The FA45 vision sensor houses in its very compact (45 x 45 x 64 mm) and highly insulated (IP65/67 Standard) continuous-casting aluminum housing all that is needed for professional imaging: CCD camera, optional white-light or red-light LEDs to light the object to be measured, standard M12 sensor socket connectors, PLC compatible I/O and data interface (RS 422, 100-Mbit Ethernet) as well as a high-powered DSP for data processing. In spite of this extensive equipment, the purchasing expenditure for the FA45 is well beneath that for a classical vision system.

The code reader variation of the FA45 is capable of reading DataMatrix code of the ECC200 type and several bar codes. Thanks to its efficient reading algorithm the vision sensor will also recognize without problems difficult-to-read codes – among those particularly directly marked codes (e.g. nailed or laser-written, with weak contrast, on mirrored surfaces or with irregular background), but also damaged or soiled codes. "The FA45's high reading reliability and its favorable purchasing price were the determining factor for the end-user," emphasizes Markus Koslik. Also, SensoPart's competence in application matters was persuasive: "With our lighting field test we were able to prove that the solution proposed by us is functioning at 100 %."

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www.sensopart.de

12 Megapixels, 25 fps and Global Shutter

Toshiba Teli has announced the CleverDragon CSC12M25BMP19 camera, aimed at the most demanding, uncompromising requirements of industrial image processing. The camera features a monochrome CMOS chip (24,6 × 18,5 mm sensor area) offering 4,096 × 3,072 active pixels with a pixel size of 36 µm^2 and the ability to output 25 frames per second. The frame rate can be increased even further by selecting particular regions of interest (ROI) – for instance, up to 48,662 fps are possible when outputting individual scan lines with a bit depth of 10 bits. Furthermore, the highly sensitive sensor enables to take low noise pictures – with a high dynamic range due to the multi-slope exposure method. A global shutter enables distortion-free imaging of fast-moving objects as required for the most machine vision applications.

Framos GmbH
Tel.: +49 89 710 667 0 · info@framos.eu · www.framos.eu

Look Behind the Scenes

The 3D Vision Sensor SR2400 was designed especially for edge relevant applications in different areas. Operational fields are for example glass or photovoltaic business. The exact position for the edge can be detected. After processing, the edge can be inspected for quality reasons. Further applications are the exact determination of clearances or measuring of precipitous glue applications. The two-channel sensor is factory-calibrated to a single coordinate system. A time consuming inline calibration is not necessary. Therefore the sensor can be installed within a very short time. Because of its compact design and its robustness SR2400 is dedicated for robot based applications. It is available in two versions of resolution: 50 µm and 25 µm lateral.

SmartRay GmbH
Tel.: +49 8171 9683 400 · info@smartray.de · www.smartray.de

Smart Camera System

With its new Eyespector Camera series NET offers an extremely compact and intelligent system for image processing. Eyespector is more than just a Smart Camera. It is available as a complete image processing package for various areas of application. With a computing power of up to 8,000 MIPS the system reaches the current level of computer technology performance. The cameras cover resolutions ranging from 640 x 80 up to 1,600 x 1,200 Pixel for capturing grey-scale images with CCD sensors, as well as resolutions for color and other frame rates up to 250 fps. The software runs under standard Windows XP, Vista and Linux systems. Eyespector combines high performance hardware with Eyevision, the already integrated image processing software.

NET GmbH
Tel.: +49 8806 9234 0 · info@net-gmbh.com · www.net-gmbh.com

Intelligent Cameras for OEMs

VRmagic offers versatile intelligent components for OEM customers – from manufacturers of vision sensors to suppliers of code readers. These components represent an inexpensive alternative to applications with embedded PCs. The camera designs and features can be adapted individually to customer requirements. The range covers everything from inexpensive mass-produced single-board versions to individual designs with remote sensor. Developers can transfer their own algorithms to the camera from a PC using a cross-compiler, since both the host system and camera have the same API. Equipped with the DaVinci processor from Texas Instruments, the components feature a 300 MHz ARM9 processor running Debian Linux as an autonomous standard operating system and a 600 MHz DSP with 4,800 MIPs.

VRmagic GmbH
Tel.: +49 621 400 416 0 · info@vrmagic.com · www.vrmagic.com

Digital Video Surveillance with Cell/B.E. Processors

Given that there is an increasing need for security, digital video surveillance systems (DVS) are becoming more complex. However, these systems meet the limits with regard to size, scalability, reliability and easy management. IBM Cell/B.E. Blades, efficient H.264 codecs and optimized image processing components from Matrix Vision offer the base for very compact DVS solutions, which cope the named challenges even in larger installations. The Cell/B.E. processors, which drive the Roadrunner in Los Alamos to be the fastest computer of the world, features one core as a Manager (PPE) and eight cores (SPEs) each with 3.2 GHz which are optimized for fast parallel processing. Over 1,000 cores are available in a fully mounted 19" rack. The high-optimized H.264 software codec guarantees a much better compression rate compared to other compression standards and implementations.

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

One Eye Is Better

The new autocollimation retro-reflective sensor FR 20 RLO from Sensopart sees perfectly in close-up range and can even look through bore holes. In contrast to standard light barriers, this sensor is ideal for the detection of objects at short distances as well as behind bore holes and apertures. Unlike "two-eyed" retro-reflective sensors, the light beams transmitted and received are directed through the same lens with the autocollimation principle. A small bore hole or slit therefore suffices for autocollimation systems to detect objects moving behind them – the FR 20 RLO can therefore, for example, detect objects behind guide rails or look through the valve hole of a bicycle rim to position it for automatic spoking. As an autocollimation sensor is ideal for use in the close-up range, it can be positioned very close to the process.

Sensopart Industriesensorik GmbH
Tel.: +49 7673 821 0 · info@sensopart.de · www.sensopart.de

Fast 4 Megapixel Camera Link Camera

Basler Vision Technologies is launching its new A406k camera, which is currently the fastest four megapixel camera with a Camera Link interface. The new camera provides 209 frames per second at the full resolution of 2,320 x 1,726 pixels. It is available in monochrome and color and extends the portfolio of Basler A400k cameras. This camera series, which includes the A402k (24 fps), the A403k (48 fps), and the A404k (96 fps), is used very successfully in automated optical inspection systems to verify the position and soldering quality of devices on populated, soldered PCBs. When the camera is used with the supplied AOI (area-of-interest) list editor, it is possible to change the size, position, and exposure time of a series of AOIs extremely quickly. This is a significant advantage because the Camera Link serial communications channel normally used to change camera parameters is limited to only 115 kbaud and would be too slow to make these rapid changes to the AOI.

Basler AG
Tel.: +49 4102 463 0 · info@baslerweb.com · www.baslerweb.com

New 2009 Machine Vision Catalog

Navitar announces the release of its new 2009 product catalog featuring a full line of optical solutions for Machine Vision, Automation, Assembly, Imaging, Measuring, Inspection and Biomedical Sciences. The 2009 catalog has an extensive line-up of over 400 products including high magnification zoom, telecentric, large format, motorized and video lenses. New additions include the SWIR fixed focal length imaging lenses, along with a section highlighting Navitar's expanded custom lens design and rapid prototyping capabilities. System diagrams, photos and technical specifications are featured throughout. The new catalog, extensive website and patented online lens selector, the Optical Wizard, make it possible for customers to make the best selections for their optical needs.

Navitar Inc.
Tel.: +1 585 359 4000 · info@navitar.com · www.navitar.com

USB2.0 Cameras with CMOS Sensor Technology

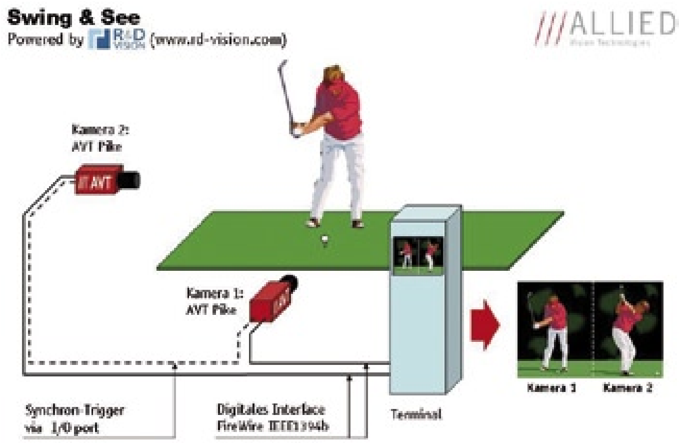
With its iCube camera family NET has developed a small, compact camera with a USB2.0 interface, which is extremely competitive due to its technical features and its ability to operate in many different areas of application. The iCube series consists of two monochrome and five color cameras in two versions, either complete with housing or as a camera module, for installation in machines and industrial facilities. Micron CMOS image sensors with resolutions ranging from WVGA to 5 MP provide an effective "plug & play" solution and frame rates of up to 87 fps for all models. Higher frame rates are easily attainable by selecting the free scalable ROI (Region of Interest), binning or the sub-sampling mode. Further technical features such as the trigger and strobe functions, together with an attractive price structure combined with CMOS technology, make the iCube family a reliable and indispensable alternative for use in fast processes where it is necessary to capture a great number of images.

NET GmbH
Tel.: +49 8806 92 34 0 · info@net-gmbh.com · www.net-gmbh.com

Combined Advantages of Smart- and Gigabit Ethernet Cameras

Leutron Vision's PicSight Smart GigE is a smart camera with a Gigabit Ethernet interface and a 32 Bit RISC processor. The camera is available with 28 different monochrome and color sensors offering resolutions from VGA up to 5 Mpixel. Application development for the camera is done in ANSI C/C++, which enables developers to easily reuse existing code. A comprehensive development package makes writing and testing applications for the camera a convenient task. Data can be uploaded to the camera over the build-in FTP interface. A web interface allows to change settings through a web browser. The PicSight Smart GigE comes with 64 MB of memory for saving multiple images and programm code, and 32 MB of flash memory for application storage.

Leutron Vision GmbH
Tel.: +49 7531 59420 · info@leutron.com · www.picsight.com



The Perfect Swing

Any golf player would confirm it: mastering the perfect swing is a matter of practice and patient training. Professional players have been using video recordings for a long time to analyze their swing in detail and then improve it. With the system "Swing & See" developed by R&D Vision of France, amateurs can now use this technology too and benefit from a powerful analysis tool on the golf course in their neighborhood. This system relies on sophisticated cameras to capture and precisely document each phase of the swing movement: the Pike series from Allied Vision Technologies. The system consists of an interactive terminal equipped with a color touch-screen display which houses the control unit and image processing combined with two AVT Pike digital cameras. The whole set is permanently installed on the golf practice tee and is weather-proof for outdoors installation. The user interface is easy and intuitive.

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

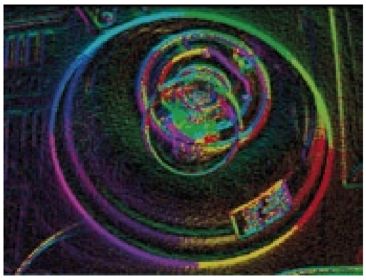
Advanced Machine Vision Software Color Capability

Dalsa announced it has advanced the color capability of its Sapera Essential software for machine vision applications. Sapera Essential (Edition 01/2009) is a cost-effective machine vision software toolkit that bundles board-level acquisition and control with advanced image processing capability. It is intended to deliver the critical functionality needed to design, develop and deploy high-performance machine vision applications, while at the same time significantly lowering deployment costs. This version of Sapera Essential provides support for Windows 64-bit and the .Net interface. With the introduction of the Sapera Essential Color Tool, the software delivers improved color capability.

Dalsa
Tel.: +1 781 964 3536 · info@dalsa.com · www.dalsa.com

System-on-chip for Machine Vision Applications

CSEM has developed a unique System-on-Chip (SoC) tailored for machine vision applications in uncontrolled environments. Its 320 x 240 (QVGA) pixel array incorporating a time-domain logarithmic pixel design provides an extremely high intra-scene dynamic range (132 dB), allowing vision sensing even in rapidly changing illumination conditions. Built-in computation of contrast magnitude and direction in the readout path facilitates visual scene analysis, while the on-chip 32-bit 50 MHz icyflex DSP/MCU processor benefits from a dedicated graphical processing unit to discharge the processor from repetitive tasks (i.e. difference between two images). Named "icycam", the SoC is optimized to facilitate image analysis and decision making.



CSEM
Tel.: +41 32 720 5111 · info@csem.ch · www.csem.ch

Generic Interface Allows Flexible Integration

For its uEye LE range of USB cameras, IDS now also provides a GenICam interface. This generic interface allows for increased flexibility in camera integration. In combination with the excellent price-performance ratio of the LE series, the board-level versions in particular offer a very interesting solution for system integrators and OEMs. Programming with a standardized API quickly pays for itself, especially in frequently changing hardware environments. The USB cameras of the LE series are available as a CE-B certified housing version with C/CS-mount lens connection and as a space-saving board-level version with or without S-mount lens holder. State-of-the-art monochrome and color CMOS sensors offer resolutions from WVGA (87 frames/sec) to up to 5 MP.

IDS Imaging Development Systems GmbH
Tel.: +49 7134 96196 0 · info@ids-imaging.de · www.ids-imaging.de

Images of Inaugural Parade

Point Grey Research today announced that its Ladybug3 spherical digital camera system was used to capture images of the 56th Inaugural Parade on January 20, 2009. NASA participated in the historic parade with its Lunar Electric Rover, which was equipped with a Ladybug3 to capture 360-degree digital video footage of the parade and Presidential Review Stand. The camera was mounted at the top of a mast on the rover and connected by a 10 m IEEE 1394b (FireWire) cable to a Dell Precision M90 Intel Core2 Duo laptop, which was equipped with a FireWire ExpressCard. Using the Ladybug SDK, NASA was able to control the camera, acquire full 12 MP images (2 MP from each of the six sensors) at 15 FPS for approximately ten minutes, store the footage to a video stream file, then post-process the data into panoramic AVI's and still images.

Point Grey Research Inc.
Tel.: +49 7141 488817 0 · infor@pointgrey.com · www.ptgrey.com

INSPECT

Automation

AUTOMATION: MEASUREMENT – INSPECTION – IDENTIFICATION – GUIDANCE

The Automation section features turn-key systems and applications. 3D robot guidance in automotive assembly lines is a topic which is just as important as the quality control of wine bottles in Napa Valley. Surface inspection of webbed material in glass, plastic, metal and paper production, inspection of print quality in the printing industry or on cans of tuna, inline dimensional checks of entire car bodies – these are all topics you will find in the Automation section. Success stories with testimonials from users show not only the performance of technology in various fields, but also guide you to suitable suppliers for your application.

Too Little, or Too Much?

Vision Sensors Measuring Salt Filling Levels of "Bad Reichenhaller Markensalz"

Südsalz is the most efficient and biggest German supplier of salt. You will find this market leader's brand name in every kitchen cabinet: "Bad Reichenhaller" salt. Südsalz covers all uses like salt for human consumption, animal-food salt, industrial-use salt, pharmaceutical salt and road salt with their comprehensive program of rock and salt produced by boiling. To assure the quality of their human consumption salt the Bad Reichenhall, Bavaria, based salt works employ sensors by Wenglor. Not only optoelectronic and induction sensors are applied, but the processes are also improved by vision sensors.

© ŠSilver/Fotolia.com

Deep under the mighty layers of rock of the Bavarian Alps, for more than 250 million years the salt of the primeval sea has been resting. Dissolved by rock water it settled, as alpine brine, in a hollow of the Bad Reichenhall Depression. This alpine brine, with its maximum salt content of 26.5 %, contains vital minerals and trace elements. From this natural alpine brine the pure alpine salt for Bad Reichenhaller brand name salts, spice salts and spice salt mills is obtained.

From Alpine Brine to Quality Product

The subterranean brine deposits are exploited through deep-reaching drilled holes, the alpine brine being pumped through a pipe line to the Bad Reichenhall salt works. Alpine brine production is about 300,000 m^3 per year. It is used solely for the production of the finest kinds of food salt. First, the alpine brine is passed into the huge containers of a vaporizing plant, freed of impurities and then heated to its boiling point. Thus, the water evaporates, with the original al-

Wenglor sales engineer Alexander Berchtold (left) will give advice and support to Thomas Oeggl, electrical systems manager, when technical problems need solutions

Sensor-monitored salt packaging plant

pine salt settling. For this procedure, the people at Bad Reichenhall use a special energy-saving thermo-compression method.

In a centrifuge any residual water is separated from the salt, and the salt is hot-air dried. What remains, is alpine salt of the highest quality. This very costly method will yield pourable salt, the edges of its tiny crystals being rounded.

"When the salt is purified, dried and refined it is packaged," explains Thomas Oeggl, the responsible person for electrical engineering at Bad Reichenhall. He has been with the salt works since his apprenticeship in 1975 and knows every detail of the packaging machines. "The quality of the products shipped got to be right," he says. And one of the main criteria is the filling volume in the package. For measuring the filling levels in each package, Oeggl, a master craftsman, decided on the use of vision sensors.

When possible suppliers were considered, Alexander Berchtold, Wenglor sales engineer prevailed over his competitors. "Berchtold came and had a look at this application, installed and tried out the vision sensor, and after a few minutes, detection of the filling level was functioning," recounts Thomas Oeggl.

If the filling level is right, the packet is sealed

Automatic Focusing

The salts works at Bad Reichenhall use five BS40 vision sensors. The sensors belong to the group of identification products that include industrial imaging, OCR readers and scanners. Wenglor's vision sensors in their compact housing do a fast and reliable job of imaging. Camera, lens, lighting and processing unit are integrated in the compact housing, with the optional possibility of external lighting. A further asset: a motorized autofocus, always guaranteeing a sharp image.

Resolution, reduced optionally, allows an image repeating frequency of up to 100 images per second. The image can be processed in either color or monochrome form. The adjustable exposure time and LED brightness of the sensor will give an optimum adaption to the application. A USB connection and an operator-friendly software simplify sensor-to-PC data transfer.

This vision sensor offers numerous functions which can also be interconnected. Objects are identified independently of their position and their angle of rotation. Also, the working area can be defined individually and areas causing interference can be cut out. This is why the Wenglor vision sensor functions with any background. For purposes of quality assurance the sensor will deliver pictures for diagnosis to the personal computer.

Among its functions are analysis of shape, pixel comparison, linkage of functions, presence check, and comparison with a reference image. The vision sensor has four outputs which can be adjusted to different events. Up to three objects can be linked together.

The Wenglor software allows the sensor to be quickly adjusted to the desired application. Using the operator-friendly software, configuration can be carried out via a PC or a laptop. In addition, selection of up to ten pre-stored projects can be done via the digital input or on a touch screen.

No Standstill When Using Vision Sensor

"We package 400 packs per minute," says electrical-system master craftsman Thomas Oeggl. Cartons are folded, pasted and filled. The vision sensor supervises filling volume. If, for instance, there is a dark area on the reference image, that is, the number of pixels does not tally, the sensor will issue a fault signal. A fork then removes the product. "The dark area in the image indicates that salt is leaking somewhere," explains Wenglor sales engineer Alexander Berchtold. If the filling volume is o.k., packs are folded on top and pasted and the correct number of them are cross-shifted into a larger carton for shipment.

Thomas Oeggl is happy with the function of the vision sensors. Nevertheless, Alexander Berchtold is always there when a question arises. "Also, we can always count on getting through on the hotline, which is not the case with every company," says Thomas Oeggl. The Wenglor technical support personnel will quickly find an answer to a customer's urgent question. This way, Südsalz, too, is able to optimize their processes and avoid standstill of their machinery.

Valuable content and the natural purity of the alpine brine are the reasons for the high quality of Bad Reichenhall products. Wenglor vision sensors make sure that it remains that way.

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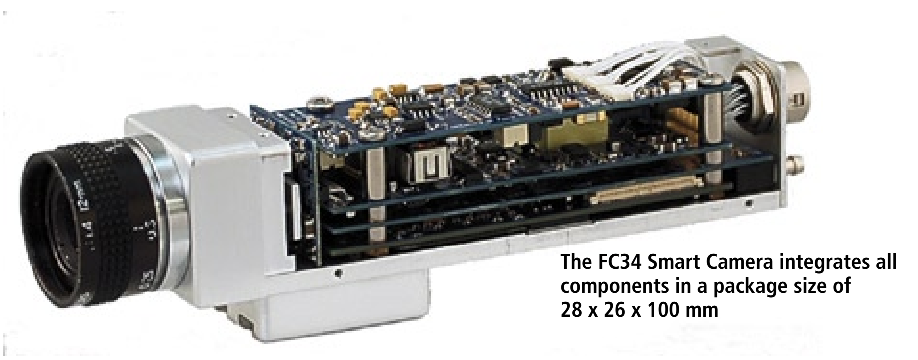
100% Inspection – 100% Purity

Smart Cameras Revolutionize Bottle Inspection

In recent years, rapidly increasing product liability costs have forced manufacturers of pharmaceuticals, containers, and other sensitive products to institute inspection procedures for each individual item they produce, with zero tolerance for defects. Such product liability expenses include costs of litigation and product recalls, as well as contractual penalties and lost revenues from sales that otherwise would have accrued. For example, manufacturers of items such as recycled products can no longer rely on manual statistical inspection, and instead must adopt systems that examine 100 % of items produced.

As a result, machine vision companies have been pressed to provide significantly enhanced inspection ability while lowering per unit inspection costs. In response to these pressures, machine vision companies have integrated a camera, frame grabber, and object recognition and classification engine into combined low-cost units known as Smart Cameras, which increasingly have been adopted for machine inspection.



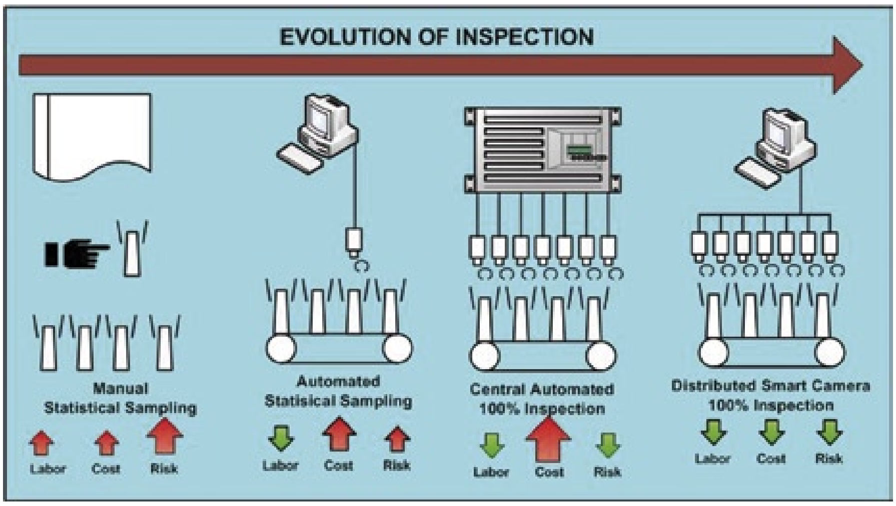
The FC34 Smart Camera integrates all components in a package size of 28 x 26 x 100 mm

The pharmaceutical industry was among the first to adopt one-hundred percent inspection procedures, because of the life-threatening risks associated with defects in its products. Until recently, processors of re-useable containers such as bottles, continued to rely on manual inspection with sample-based process control. Such manufacturers depended on users' tolerance of inconsistency and occasional defects. For the reasons discussed above this approach to product inspection has proved unacceptably costly.

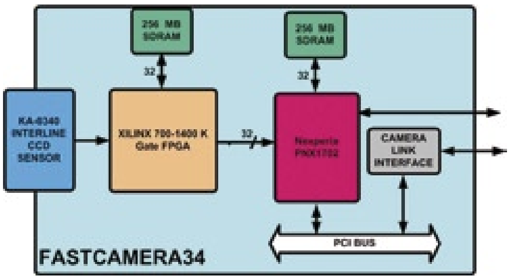
As a result, beer producers, for example, which rely on bottle recycling, can no longer survive as volume manufacturers without adopting policies of zero contamination defect tolerance.

A significant problem with the application required by such policies is the high rate of image data which the process generates. An inspection line can process over 4,000 bottles per minute, while generating as many as ten images of each bottle. Thus, such applications can easily produce more than one gigapixel per second of image data. Transporting such large volumes of data from cameras to vision systems and processing that data requires large, costly system installations.

One solution to this issue is reducing the inspection rate while increasing the number of inspection lines. Traditionally, the high cost of inspection hardware rendered this solution prohibitively expensive; however, the recent availability of high- performance, low-power image processing systems has now made it viable. For example, the FC34 Smart Camera from FastVision LLC contains a high-speed imaging system, a digitizing frame grabber, and a high-performance FPGA/image processor, all in a package smaller than most machine vision cameras (28 mm x 26 mm x 100 mm). The FC34's imaging system is based on the Kodak KAI-0340 640x480 sensor, operating at 210 frames per second, and its FPGA/image processor is the PNX1702, from Nexperia. The FC34 Smart Camera is a self-contained machine vision inspection system that can be programmed with image processing algorithms and includes a "go, no-



The Evolution of assembly line inspection



Block diagram of image processing engine

go“ determination output that can be sent to the mechanical rejection unit of a multi-line inspection system running at high speed.

The FC34 Smart Camera’s recycled bottle inspection application transports image data from the integrated sensor, operates the rejecters, and triggers light sources without sending images outside the FC34. It supports a LVDS serial channel to report statistical data to a central system and also supports a camera link interface for setup and transport of defect images. This smart camera internally images each bottle ten times as it is rotated in the field of view, processes the images, and provides a reject signal, without support from additional equipment.

Integrated solutions like the FC34 are increasingly common. While the beer bottling industry provides an excellent example of the trend toward adoption of one hundred percent, zero defect, high speed inspection procedures, similar issues can be expected to arise in other consumer or health-related, high volume industries. Such industries will require the installation of many more high- performance inspection systems to keep pace with production volume while identifying and eliminating all defective products. This trend will cause machine vision inspection systems to require the latest in lighting, optical, camera, and computer components, such as those in smart cameras, to provide cost effective solutions.

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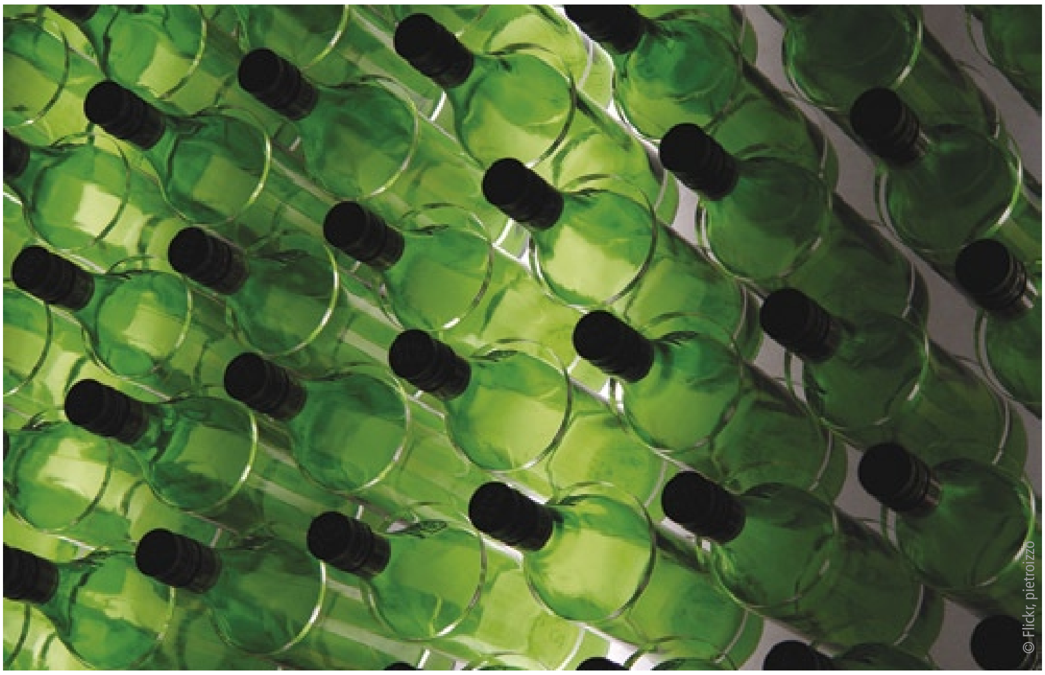
Message in a Bottle

Smart Camera Ensures Traceability in Bottle Manufacturing

Glass is elegant, and glass packaged products stand out. With many unique shapes, glass containers give the product identity and character. And glass is fully recyclable: an old and used glass bottle can be remade into a new, clean glass bottle. When glass is made it is heated to around 1,600 °C, thus killing off any bacteria. Glass is a truly environmentally friendly material und this is why its triumph as packaging material, especially for food and beverages, is continuing as strong as ever.



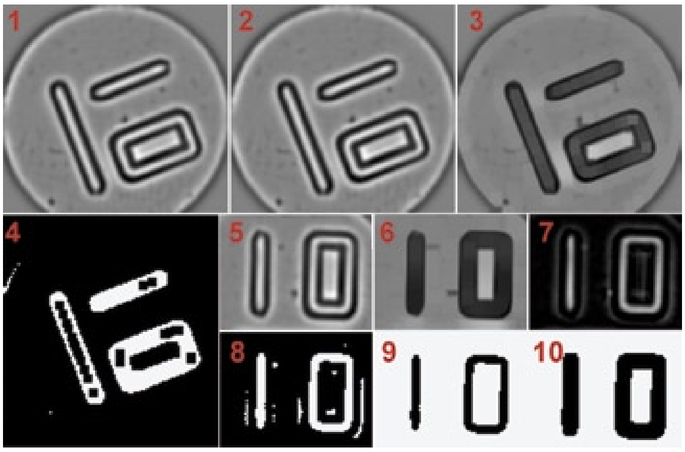
In a manufacturing line for glass bottles for beverages several pressing molds work side by side. To track defective bottles, every bottle is marked with a unique number on the bottom. This number identifies the tool that produced the bottle. So in case of a problem the causing tool can be identified and repaired.
A vision system had to be designed to read the bottle's number. Due to the optical nature of glass and the bended surface of the bottle it is not possible to achieve a constant and clear image. The press tool number varies greatly in brightness, contrast and aspect ratio from image to image. Additionally the system had to meet a performance of checking 30 bottles per second. This is a definitely big challenge for a vision system.

Character Features

Despite the varying quality of the image taken by the camera this task can be solved very stable and efficiently by the advanced algorithms of the Matrox Imaging Library (MIL). The core module of MIL used for this task is the String Reader, a very robust tool for locating and reading characters under harsh conditions. Contrary to standard OCR algorithms, which are based on a template matching technique, String Reader uses an approach based on geometric features of the single characters. This is why String Reader is able to accommodate changes in aspect ratio, size, contrast, brightness and to read heavily degraded fonts. All images are pre-processed by blob analysis and different morphological, arithmetic and geometric operations and then are fed into String Reader to decode the number.

Compact Platform

Besides developing a suitable algorithm for decoding the strings it was part of the project goal to propose a highly integrated hardware platform. Smart cameras usually are a good choice for straightforward applications like 2D code reading, pattern matching or metrology. Nevertheless the new Matrox Iris GT smart camera was proposed. Iris GT is fast enough to process an image below 30 ms, features a sturdy, dust-proof and washable IP67-rated housing with industrial grade M12 connectors and can be operated from 0 °C to 50 °C. The vision application itself can be easily configured and deployed with the Matrox Design Assistant, an intuitive, versatile and extendable integrated development environment which eliminates the need for conventional programming.



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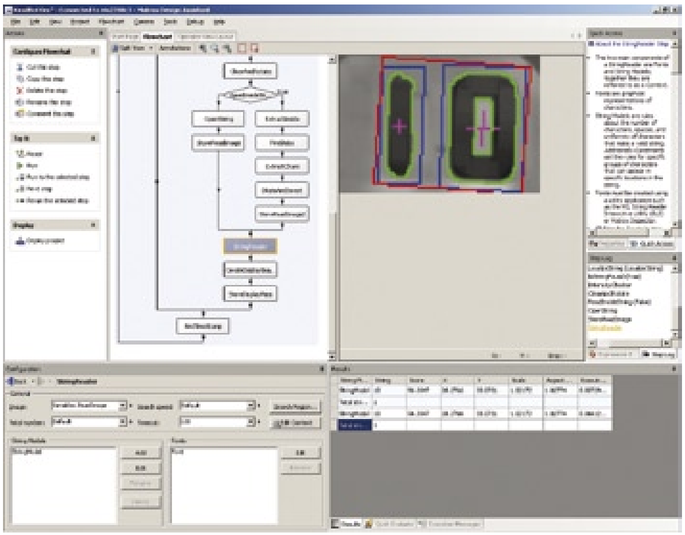

Development and deployment is done through the integrated development environment Matrox Design Assistant (Photo: Matrox Imaging

Speed Increase by 300 %

The heart of the robust camera's hardware is the brand new Intel Atom CPU clocked at 1.6 GHz (mainly used in Netbooks so far), which features unmatched performance for embedded systems like a smart camera. Thanks to latest technology like this CPU, an internal Matrox FPGA, fast PCI-Express lanes and the real time operating system Windows CE 6.0 the camera runs up to 300 % faster than its predecessor. Available CCD sensors include the latest generation of Kodak's 640 x 480 at 100 fps (KAI-0340S) and Sony´s 1,280 x 960 at 22.5 fps (ICX445AL) and cover a great range of different applications. Communication with external devices is done through Ethernet (10/100/100 Mbps), VGA, USB (for keyboard, mouse and touchpads), RS-232, opto-coupled trigger- and strobe-outputs and a current controlled output for interfacing to LED lighting directly.

Design-Assistant – the Flow Chart Approach

Development and deployment is done through the integrated development environment Matrox Design Assistant. The application is interactively configured on the camera and thus foregoing the need of conventional programming. There are two main tools within Design Assistant: the flow chart designer and the editor for the operator view.

The flow chart represents the vision application's sequence of processing steps and how the results of different operations are combined, evaluated and processed. Parallel to interactively designing the flow chart step by step, each of its steps is configured through a configuration mask. All processing and analysis modules of the field-proven MIL are available within the flow chart. The Design Assistant displays all relevant information (flow chart, configuration masks, online-help, debug information) in a very user-friendly way, so the design process is well structured and clearly represented at any time.

Web Based User-interface

The flow chart represents the sequence of the image processing during the design time, the operator view is the user interface presented to the end-user during run time. The operator view is a web based user-interface, which can be designed within the Design Assistant. All graphical elements (image display with overlays, buttons, radio buttons, text areas, graphics, …) for input and output are arranged on the website and get linked to the results of the flow chart. The user interface can be displayed by any PC with a web browser like Microsoft Internet Explorer.

Problem Solved within Two Days

Solving of this challenging OCR application is done through combining two things: a robust imaging algorithm based on the field proven Matrox Imaging Library and a high-performance, highly integrated hardware platform for harsh environments. Time-to-Market is very short because the development of application and user interface is easy, fast and convenient. In summary this application is a characteristic example for Matrox Iris GT, which offers the best of both worlds: a full industrial smart camera together with a new flexible concept for developing and deploying vision software.

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Fatigue-free at the Steel-Mill

Vision System Monitors Strip Steel Production

Smart Cameras cover a broad range of applications implemented in a diverse field of industries. Image processing expert Bi-Ber, e.g., has implemented a control system for the manufacturing of profiled strip steel based on a VC camera. Installed adjacent to a grinding machine, the high-capacity vision system continuously provides real-time data, thus allowing for optimal tool adjustment.

The strip steel band, which has a trapezoid profile, travels through the machine at 500 mm/min. The system monitors the top and the bottom width and the width of the band's flanks. The measurements must be displayed on the control monitor and must be made available for the tool position adjustment in real time.

An intelligent camera from Vision Components, which features a 400 MHz processor with a 3,200 MIPS computing power, executes the measurements. The camera, suitable for rugged industrial environments, is mounted vertically to realize downward vision. LED lights above and below the strip steel make the measurements detectable by the camera: the outer edge is discernable due to transmitted light from below, and the surface is made visible by reflected light. The camera is fitted with a telecentric lens, reproducing the measurements true to scale independent from the distance to the object. It transmits the readings to a connected monitor, which displays them.

Signal Analysis and Operation

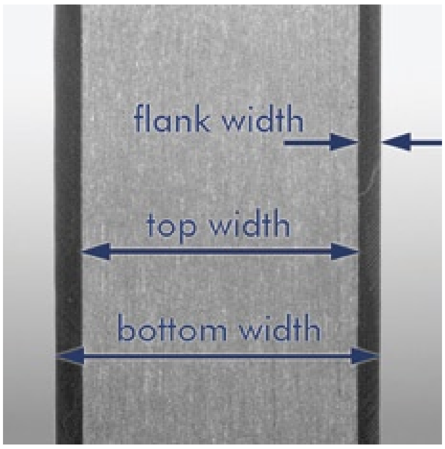
The system software has been customized by Bi-Ber to suit this specific control application. If the measurements deviate from the defined tolerance, a warning signal is issued. The monitor displays the current values along with the average values of a freely se-

VC4038

Featuring a 400 MHz processor from Texas Instruments, the smart camera VC4038 has a 3,200 MIPS computing power. Its 1/3" sensor with a 640 x 480 pixel resolution provides a maximum frame rate of 63 fps (126 fps in binning mode). The VC4038 comes with 32 MB DRAM and 4 MB Flash EPROM for program and data storage. The flash capacity can be extended by 128 MB with an optional SD card. Standard equipment includes an SVGA video output, four digital inputs, four digital outputs, and a high-speed trigger input that enables jitter-free image recording even at high reading frequencies. The camera features both, an RS232 interface and an Ethernet interface, allowing for an easy integration into existing automation environments. The real-time operating system VCRT enables multitasking. The freely programmable, compact units are stand-alone image processing systems that can be integrated into a wide range of applications.

Strip Steel Production

Roll forming machines are employed to manufacture metal sheets of any thickness from steel slabs. The sheets can then be cut and shaped as required. EN norms define width and straightness tolerances. To suit the various possible applications, manufacturers and users may set down narrower tolerances. Further quality requirements on strip steel include breaking strength, even coating (to ensure, amongst other things, complete corrosion protection and color fastness), and resistance to environmental influences. Depending on the material and the measured data, different methods can be used. Coating thickness, for instance, is measured contact-free so as not to destroy the surface. In addition to mechanical testing and vision systems, sensors are employed to measure thermal and radiometric performance. Since all production steps are characterized by high throughput speed, the measuring results must be recorded and processed in real time. Vision solutions have the advantage of being suitable for industrial applications, fast and flexible: they enable exact measurements at some distance from the test piece.



Camera perspective: Top view of the material with widths to be measured

lectable number of previous runs. Measurements outside of the tolerance level are displayed in red, yellow figures exceed the warning level, green figures are correct. The system is operated by means of a clearly laid-out keyboard and the monitor. Users can configure different types of strip steel via an operating menu. Target values and tolerances can be individually specified and saved. The strip steel type can be selected either via the menu or automatically via the digital inputs of the smart camera.

Vision system for the monitoring of endless bands of strip steel

Solution with Staying Power

The camera is ready to operate approximately one second after voltage is applied. It automatically starts the control program and continuously takes measurements until a different function is activated. The system executes up to five measurements per second. The readings are very stable and the measurement error is less than 10 µm.

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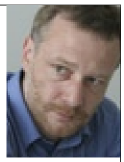

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Extra Virgin

Color Vision Sensor for Olive Sorting

Image processing is the state-of-the-art technology for quality assurance in industrial production. In fact, "Machine Vision" developed from this field in the last couple of decades. The high standards of quality which dominate the automotive industry, e.g., ensured the development from a high-end technology to standard products which are used in various ranges of application today. One field only recently developed, is the sorting of agricultural products.

The enormous cost pressure in the automotive industry lead to the fact that out of engineering solutions products were generated that are small, compact and inexpensive.
The so-called intelligent cameras or the lower level vision sensors are a result of this development. These systems are in fact complete image processing systems which did need the space of a control cabinet less than five years ago. Today the electronics and the software, featuring the same or even a better performance, are enclosed in a camera body measuring only 50 x 50 x 65 mm. The integration of the complete processing unit, including the sensor and the lighting in one body permits the operation of such systems also in harsh environmental conditions like in the food industry.

Powerful Hardware – Compact Size

In surroundings where food is produced it is normal procedure to frequently spring-clean all machines. Therefore the vision systems employed here have to be resistant to water, cleaning agents and high temperatures as well. Due to the compact integration of all components within a very small housing it is possible to install the complete unit in a hermetically sealed cover body. The modern processors installed in these systems have a very small power loss which can be discharged via the equally very small surfaces of these enclosures. Thus the vision sensors are not only applicable everywhere without a control cabinet but they are also extremely robust towards environmental influences.

Despite the compact design all components found in a PC based system are also available with the vision sensor. The systems support a real time operation system with an Ethernet stack for the communication with the outside world, digital I/Os and a serial interface. For image acquisition the same high-quality sensors (e.g. from Sony) are used that are employed by "non-smart" cameras. The processing power of the vision sensor ranges up to 8,000 MIPS which equates a Pentium CPU with a frequency of 2 GHz.

From Smart Camera to Vision Sensor

There are no hardware limitations for porting the powerful software packages which have been developed on the PC-based architectures to the compact systems. Thus powerful and user-friendly vision software is available. In the comfortable way of programming these systems do not fall short to the discrete build systems. The image analysis software can be generated simply by drag and drop so that the users themselves can parameterize and/or program these systems and by thus integrate them into their machines.

With the goal to even more simplify the usage of the vision sensors, EVT modified the graphical user interface which had been originally developed for smart cameras. The function range has been systematically reduced to specific applications and the user interface has been customized. In this way the EyeSpector smart camera family turned into the EyeSensor family. The systematic simplification of the software turns a smart camera into a vision sensor. The hardware stays the same, only the range of available functions and the operation are simplified until the vision sensor can be applied as easily as a light barrier.

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Olive Sorting in the Twinkling of an Eye

One example for a highly specific sensor from the EyeSensor product family is the sensor for the sorting of olives. This sensor is based on a smart camera with a color image sensor, the image analysis is realized with the color vision tools from the EyeSpector software. A special user interface has been developed so that the user does not need to deal with any image processing specifics. The user only has to teach-in the color of the olives and – optionally in an advanced extension – the spots that can occur on the olive surface. The teach-in procedure is especially adapted to the olive sorting machines.

The olives fall on a sorting tray with n x m rows and columns. At each intersection there is a recess for one olive respectively. As soon as the tray is filled with olives the camera acquires an image of the complete tray. All fields including olives are evaluated and the olives will be either sorted out or passed on for further processing depending on the match between the inspected olive and the training parameters.

The user specifies the number of rows and the columns of the sorting tray. Afterwards the user has to position the first inspection field on the tray and based on this the left and the bottom inspection field. All other inspection fields are automatically set in equidistance based on this user input. With these steps the sensor is installed and the inspection can be started. Next the color characteristic has to be taught-in. To achieve this the user puts an olive in the desired color in the left upper corner of the tray. This color is then adopted by the software as the target for sorting. Thus all fields are automatically parameterized and can now be inspected for the required olive color. This already describes the whole teach-in procedure the user of the EyeSensor vision sensor has to execute for the color control. Now the system is ready for operation. A change-over to another color is equally fast.

Color and quality grades at olive harvest

First and Foremost: the Sensor Concept

In addition to sorting for colors the user has also the option to check the olive surface for dark spots. This feature is as well realized on the basis of a sample olive placed in the inspection field. In this case the user has the possibility to set a percentage of the surface which is covered. The result of the sample olive is also a percentage which is automatically determined by the software. The result is displayed so that the user has the possibility to intervene. Again the goal for the user interaction has been to develop a system with the sensor concept as a guideline.

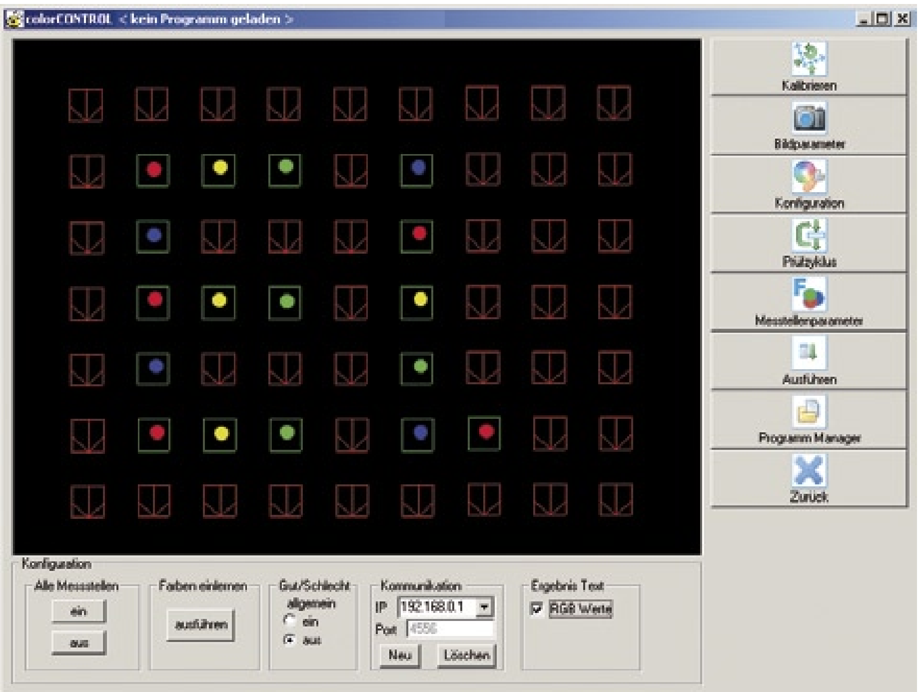
The most complex step of adjusting this sensor is to activate the section flap gate situated under the tray. However, this complete unit is integrated by the machine builder. Therefore an easy protocol based on the serial interface of the sensor could be implemented. A string of zeros and ones is transferred for each row. The gate is opened by the controller at the position one. The user of the machine does not get to see this communication because it is part of the complete unit. The advantage of this data transfer is that it constitutes a simple and robust system and can be checked by a service technician anytime. Again the sensor concept was followed through. In addition it was taken into consideration that the machine is used in areas where know how of complex technical systems is not necessarily a given.

High Comfort, Low Cost

The EyeSensor for the sorting of olives is one example for the new product category vision sensor which constantly opens up new fields where so far discrete image processing systems have been used. One reason for this success is the fact that the processing power can be compared with those of a PC-based vision system but the cost is significantly lower.

The software product is established on the hardware platform of the vision sensor, the know-how to implement successful applications is available and the price advantage will most certainly add to the success of EyeSensors.

Especially the sensor for the sorting of olives is a great example for this kind of machine vision: in the Turkish olive harvests where the vision sensors are used, it would not even be possible to install a PC-based vision system. The then required control cabinet with the climate control unit alone would have a higher price than the vision sensor.



Olive Sensor user interface in teach-mode

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Inline Profile Measurement of Precision Tubing

For the first time ever manufacturers of precision tubing can now produce to closest dimensional tolerances even if the material is soft and deforms during the production process. Inline profile systems equipped with the new Pixargus "ovality module" capture the complete profile even of tubing with irregularly shaped outside contours. Thus the ProfilControl dimension gauges ensure that the hoses will fit exactly into the connecting elements and that the connections are perfectly tight. For tubings to fit perfectly, not the diameter but the circumference is the key parameter. As soft material easily deforms during production – simply due to gravity or during reeling – it used to be a problem for many tubing manufactures to exactly measure the circumference of the products.

Pixargus GmbH · Tel.: +49 2405 47908 0
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Viscom Concentrates Its Focus

The company is one of the world's three largest manufacturers of board assembly automated optical inspection (AOI), solder-paste inspection (SPI) and automated X-ray inspection (AXI) systems. Viscom's ambitious technology roadmap for AOI, SPI and AXI calls for the company to increase its worldwide activities in all three of these areas over the next several years. The mission is to provide customers with high performance, high quality, cost effective solutions. In order to achieve that goal, the company has long distinguished itself by designing and developing advanced-technology inspection systems that closely fit customer needs. Viscom's 3-D X-ray systems are its first priority. These are based on the company's proprietary Microfocus X-ray tubes, which feature a very wide power range.

Viscom AG
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Quality Boosted and Zero Rejects

Mayer & Co., a global leader in its field has found the solution to their production problems in Cognex vision systems. While it's something we all do possibly several times a day - opening or tilting a balcony door or window, most of us are unaware of the technology behind it. Using cameras from Cognex and support from Buxbaum Automation, they were able to find the perfect solution to optimizing their production process. Rejects have been reduced to practically zero. Motivated by their success with the Cognex DVT 510 series, the engineers will be relying on Cognex quality for other production areas and lines in the future especially considering they were the first company in the industry to be certified to DIN ISO 9001 by the AGQS. The components are manufactured exclusively at the company's main plants in Salzburg and in Trieben.

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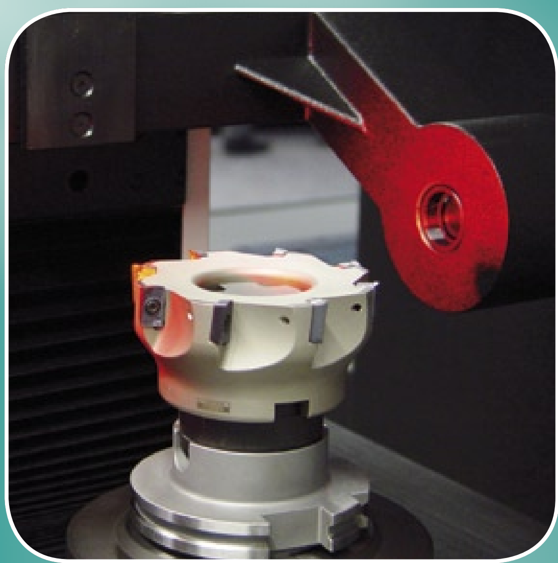
INSPECT

Control



CONTROL: MATERIAL INSPECTION AND MEASURING INSTRUMENTS

Optical measuring technology in industrial applications can be found in the Control section. Microscopy and image analysis for material inspection, the use of X-ray techniques for quality control in the field of foodstuffs, interferometry and photogrammetry for the recording of shapes in design and prototype construction are equally at home here as production monitoring with thermography, crash-analysis with high-speed cameras, optical coordinate measurement techniques or colour measurement technology and spectral analysis. From the wide field of measuring technology, two conditions must be met to make it into the INSPECT Control section: the components, products and systems are based on an optical principle, and the target group is industry.

3D-Topography and Visual Impression Concisely Recorded

New Surface Evaluation System

A new optical system measures important surface parameters like topography, roughness, structure and graining as well as the visual impression of surfaces at the same time. The mobile system works reproducible and includes storage, documentation and analysis of the measured data.

Consumers get more and more critical, the trend to provide good looking surfaces with complex micro and macro structures continues. The structural values of the surfaces are reflected in roughness, graining, texture, waviness, porosity, fibrousness and give surfaces an additional optical and functional value. People recognize this value and transfer it to a visual-optical overall impression and thus, the surface is characterized regarding its quality appeal and value.

Fast and Reproducible

Color and material impressions are dominated by the surface topography and its visual impression. The evaluation of the surface texture is of particular importance with regard to functionality, e.g. the avoidance of reflections in the automotive interior and of the tactile surface properties like haptics, grip or softness. As a result, surface evaluation systems, have to record the micro and macro topography – such as roughness, graining, texture and structural values in a highly resolved, fast and three-dimensional way. Moreover, they have to provide them with individual numerical values and at the same time record and document the visual impression to the human eye. Crucial for such a surface evaluation strategy or such a system is its reproducibility, fastness and mobility.

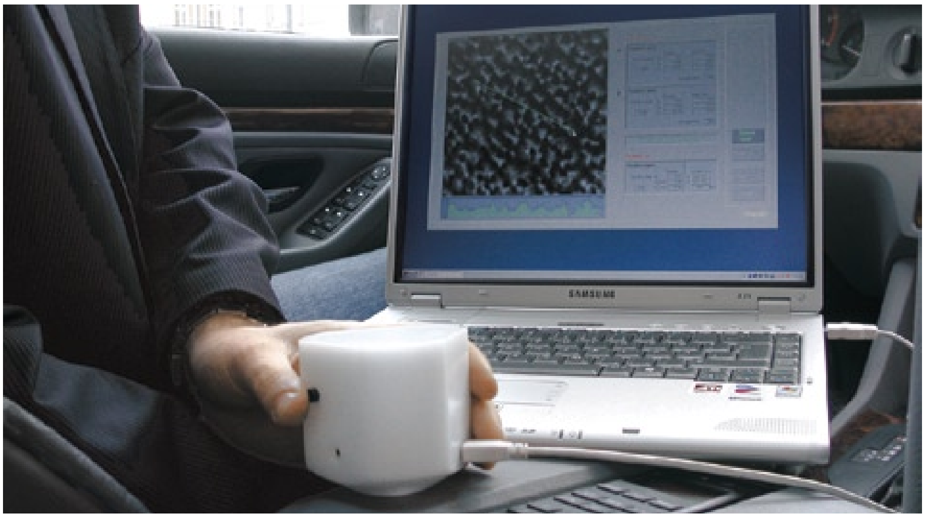
The new Traceit measuring system of Innowep meets all these requirements.

It works according to a patented kind of "shape by shading" principle. Several illuminations at different angles to each other are emitting light. The illuminations are located around a sensor head. In another step the visual impression of exactly the same area is taken by the same sensor and analyzed in respect to the light intensity distribution.

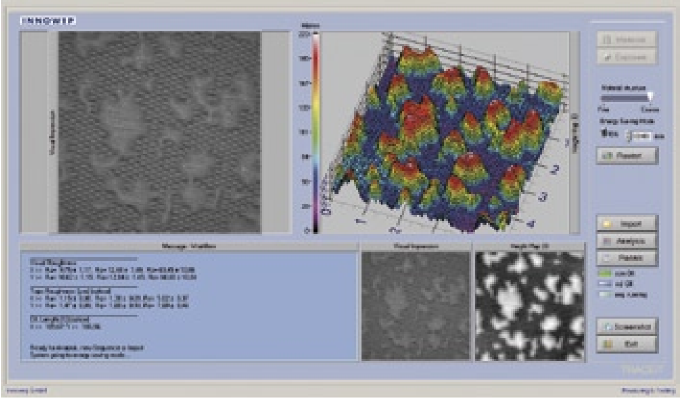
Due to the fact that the complete surface is recorded at once, the system is much faster than conventional line scanners. After a maximum of one minute, the topography of the standard measuring area of 5 x 5 mm is recorded, evaluated and displayed in a resolution up to 1.5 µm. The measuring head is directly connected to a modified notebook.

The Traceit system operates also without external power supply and can be used in this way as a fully mobile unit.

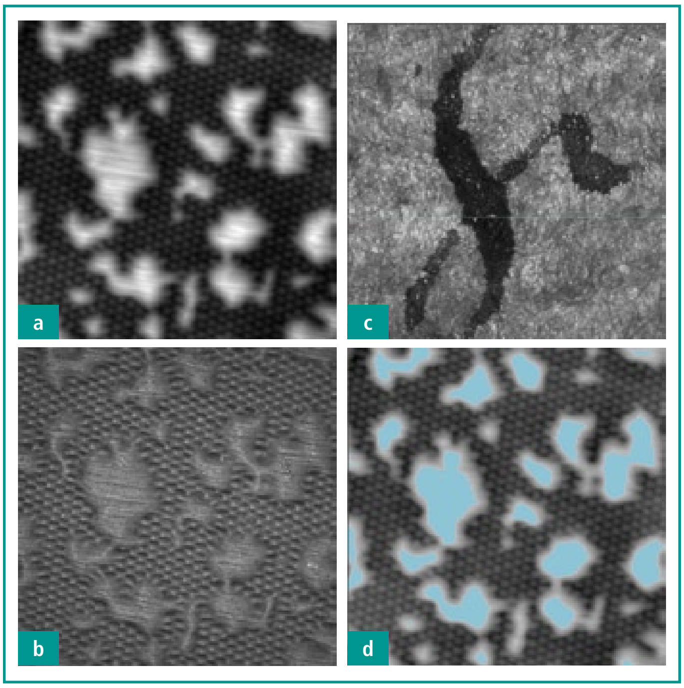
The measuring system records 3D topography values as well as the visual impression at the same time in a reliable fashion. The topography values and the visual impression are not only documented but are also transformed by an analysis tool into various roughness, structural and graining indices, light intensity distribution, always including standard deviations. This is done in the x and y direction separately. As a result, dependencies on a preferred direction – caused for example by production – can be recognized and examined. The area evaluation is carried out on a maximum



Traceit mobile



Main window with visual impression (left) and 3D diagram of the topography (right) of an artificial leather sample



Direct comparison of topography (in top view, a) and visual impression (b) of an artificial leather sample; in the particle mode the effective contact area (here the uppermost 50 µm) are marked turquoise (c); with the transmitted light unit the cloudiness of paper can be evaluated (d)

“evaluation length” of 15 m, 7.5 m in the x- and 7.5 m in the y-direction. This is also valid for the visual impression which is transferred into “visual roughness” indices and thus allows a direct comparability with other samples. Moreover, it is possible to draw a freely definable line c in the measuring area which allows a valuation of local topography and local visual light intensity distribution.

Besides the evaluation of the surface based on different roughnesses; a mode for particle analysis is available. With the vertical sections of this mode, the topographies can be examined regarding particle or pore distribution, percentage contact area or structure. This is very useful for the examination of the contact area with the help of other materials or the human hand and for the determination of the proportion of structure valleys in which dirt may accumulate. This tool is also very useful for monitoring, damage documentation and analysis at a surface, due to chemical wash off or mechanical abrasion.

The system displays the total area of the particles as absolute value and as proportion of the total area as well as the average particle size.

Mobile Use on the Spot

The mobility of the Traceit system enables the use on the finished product, e.g. in the interior of an automobile or quality assurance measurements directly at the production line. The application of the system ranges from coordination between designers, developers and quality engineers. The fast and non-destructive verifiability of the surface parameters and the visual impression help to identify problems and help to proof that these problems were corrected.

The Traceit system consists of a handy mobile sensor which is connected to a notebook. By means of special measuring, evaluation and analysis modules, the visualization and evaluation of the surface takes place via the notebook. If a light-transmitting table is used, it is possible to investigate transparent or translucent materials like glass, foils, fabrics or paper. Therefore, besides other functions, the system is able to measure and evaluate material density distribution as cloudiness, i.e. the lignin distribution in paper or parchment.

The importance of the visual surface is well-known to designers and manufacturers. But up to now it was only insufficiently possible to measure and evaluate the impact of micro and macro topography indices as well as the visual impression simultaneously, fast and mobile. The newly developed Traceit system helps here.

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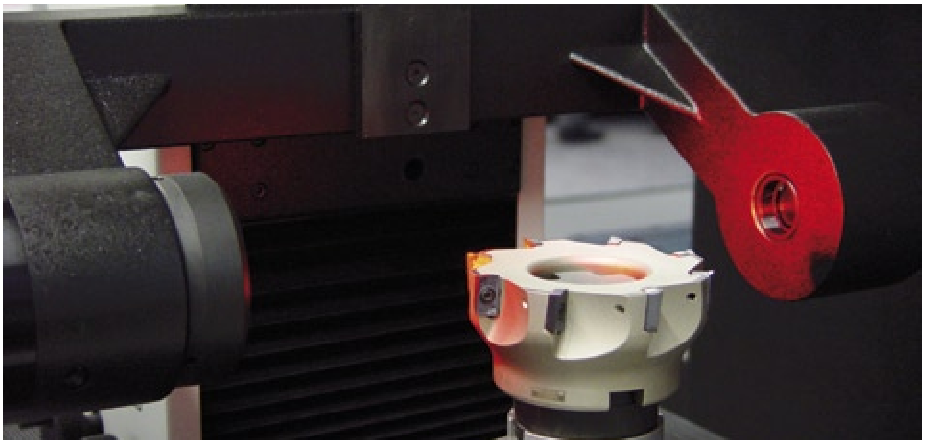
Dream Wedding

Göttingen Technology Days 2009

The "Technology Days", again successfully held by Mahr at Göttingen, gave a practical overview of the possibilities of automated quality assurance. Again, it was shown quite clearly that the question "tactile, or optical" is not really a question. Both technologies solve the most complex measuring tasks in perfect harmony.



Non-tactile optical scanning of a work piece

Marriage of convenience: multisensor measuring system makes a symbiosis of surface feeler, optics and lighting

Manufacturing companies are under a high pressure concerning quality and cost, with quality assurance becoming more and more demanding. More work pieces have to be measured more accurately, and, at the same time, more cost-efficiently in less time. Automation of measuring technology has become a mega-trend, people at Mahr agree. Thus, both problem areas, quality and cost pressure, can be managed as a whole.

The motto is, The company that automates, will do measuring jobs quicker, and in a simpler and more error-free way. At the same time, personnel involved and waste of material will be reduced.

Emphasis on Optics

High-caliber speakers of the industry gave in-depth reports on automated measuring, approaching the subject under the most diverse aspects. Mahr's product managers reported on the latest developments of shape and surface measuring. Uwe Kauder, direct-sales director with Mahr, emphasizes: "In choosing the topics, we wanted to lay the stress on optical measuring technology. These measuring devices will become more and more important in manufacturing, because their function is contact-free, very fast and also very accurate."

For example, Otto Jusko, ScD, from PTB (Physikalisch-Technische Bundesanstalt, a Federal Institute of Physics and Technology) at Braunschweig, gave a report on current research projects and the use of measuring machines in production measuring technology. PTB, he said, is doing intensive work on methods of comparing optical and tactile shape-measuring and of finding parameters that allow the best possible conformity.

For example, complete tactile scanning of cylindrical surfaces is impossible. Some applications, however, showed the advantage of having area information on the work piece. This can be effected by optical scanning only. And some faults on a component can even be found by optical 3D scanning only. Also, Dr. Jusko spoke about plans for a system with a bi-directional tactile fiber feeler with both a 90°and a -90° orientation. This would facilitate measurements of diameter and other measurements of length. Dr. Jusko is confident that this will prove as practicable as tactile scanning. PTB's further projects include 3D evaluation software to evaluate optical shape measuring, multi-wave-length interferometry to measure thin cylindrical objects (e.g. wire), measuring test masses in microscopy as well as optical area sensors for nanometer resolution of structures.

Torben Wulff from Mahr reported on surface metrology with white-light interferometry to gain 3D topographies and on new possibilities for surface analysis. In this field, too, optical systems play a major role, as soft surfaces may either be damaged by tactile systems, or the measurement is inaccurate. Also, the mechanism of tactile measuring devices is subject to wear (the feeler itself, for example). With optical systems, there is no contact with the surface, a great advantage with abrasive surfaces. Optical metrology today permits measuring surfaces that eluded tactile measuring, like, for example, liquids.

When dealing with microstructures and in establishing profiles in nanometer resolution, or in geometric assessment of reflecting surfaces, white-light sensors are the prime option. Working each on different principles, the sensors capture surface points, profiles, or even entire areas. All sensors are fully integrated in 3D vision, and so guarantee simple operation with a high degree of evaluating convenience.

Flexibility, combined with accuracy, is a demand that more and more manufacturers are facing today. Multi-sensor measuring may be the answer: Here, different sensors, like surface feeler, laser or camera, work simultaneously. The MarVision MS 982 measuring center has been designed for the two and three-dimensional measuring of large-area surfaces. Large area, in this context, means a maximum work piece size of 920 x 800 mm; the 200-mm Z-axis module being intended to record three-dimensional features. The high measuring accuracy, E1=(1.9 + L/200) µm (L given in millimeters), allows making maximum use of machining tolerances during manufacturing, reducing manufacturing cost in a most welcome way.

The multi-sensor measuring station has a modular design, based on the new USP (Universal Sensor Platform) concept. Its advantage for the user: He will operate the system with exactly those sensors that his measuring tasks really require – and upgrade later, according to his needs. With this feature, Mahr meets the trend that shows four and more sensors working simultaneously on many measuring stations. This modular design simplifies manufacture of the system with, finally, a saving effect for the user.

The multi-sensor measuring system is equipped with some highlights: The transmitted-light system, for example, is equipped with telecentric ray path as a standard. The advantage for the user is that the image of the edges is even sharper than previously possible, and this, in turn, increases the ruggedness and the repeating accuracy of the measurements with three dimensionally pronounced work pieces. A further advantage is the better highlighting of features in the entire range of the Z-axis. The equipment of the Measuring station is made complete by the latest version 4.0 of the well-proven Vision 3D multisensor software. This software facilitates, for example, an easy programming of measuring sequences.

The multisensor measuring systems are employed in quality assurance of electronics manufacturing (e.g. displays and circuit boards); sheet metal industry; printing, foils, and paper processing industries; glass ceramics industry; automotive suppliers, that are dealing with flat precision parts.

Thomas Keidel, Associate and Managing Director of Mahr GmbH: One chance in this present crisis is a rejuvenation strategy. Retrofitting old machinery with up-to-date electronics and control technology means access to the top level, with relatively small investment involved

Mahr's Torben Wulff deals with non-tactile surface scanning by means of white-light interferometry

Dr. Otto Jusko, of PTB Braunschweig, has a close look comparing optical and tactile measuring technology

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For Fast Inline Solar Cell Inspection

Andor Technology enters solar energy market with high performance NIR-enhanced CCD and EMCCD cameras to leverage photovoltaic luminescence imaging. Common faults in solar cells and panels are a known fact in the industry, and so far technology answers have been unsatisfactory. Andor promises to help researchers and industrial partners to detect such costly faults far more simply, in using its high-performance cameras the iKon-M 934 BR-DD and the LucaEM, a highly cost-effective yet fast and powerful Electron Multiplying CCD (EMCCD) camera for high throughput in-line production inspection. LucaEM uses a very low noise megapixel frame-transfer EMCCD sensor, providing single photon detection sensitivity and high NIR quantum efficiency (27 % QE at 900 nm) in an air cooled, compact, USB 2.0 camera platform.

Andor Technology
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Live Surface Investigation

A detailed view into the world of surface structures offers Fries Research & Technology (FRT) to its visitors at this year's Hannover Messe. FRT presents to its customers how their products can be characterized with regard to 3D topography, 2D contour or film-thickness in the micro and nanometer range. The exhibition booth is located within the MicroTechnology part of the Hannover Messe and can be found in Hall 6, booth E16/F3. The measurements at the FRT booth will be performed with the MicroProf 200 – an optical profilometer – and the confocal microscope MicroSpy Topo. The Topo is the entry level metrology tool from FRT which has been awarded with the German Industry Award in 2008. The tool determines rough, reflective and transparent surfaces with the highest possible resolution in 3D.

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High-quality X-ray imaging via 1-click solutions

Yxlon International GmbH, supplier of industrial X-ray inspection- and computed tomography (CT) solutions for the non-destructive testing of materials and electronics, introduces the new Y.Cheetah to its range of Feinfocus Solutions. Y.Cheetah offers effortless high-quality X-ray imaging via 1-click solutions for a wide range of continuously changing inspection tasks. The Y.Cheetah combines proven and reliable Feinfocus X-ray technology with advanced high-speed flat panel detector technology. Its innovative manipulation capabilities take efficiency in operation control and usability to a standard unmatched in the industry. Zoom+ Technology deploys synchronized tube and detector motion, giving users a truly constant image contrast at the highest resolution. In addition, PowerDrive enables the repositioning of imaging components at constant magnification for higher contrast and power, lower noise, or fast imaging and 3D scanning. Both 1-click solutions allow even inexperienced operators to fulfill complex inspection tasks.

YXLON International GmbH
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Inspection of Surfaces

The visual, optical inspection of surfaces in bores is difficult and personnel-intensive, especially in short cycle times. Hommel-Etamic has been involved in the automatic inspection of the surfaces of engine components, such as cam shafts, for many years. The company plugs another automation gap with the development of the IPS-10 internal inspection sensor. Its special feature is the combination of a short inspection time with a high resolution. The internal inspection sensor is especially suitable in cases where component bores have to be inspected in short cycle times. This applies to a number of components in the automotive industry such as main brake cylinders, wheel brake cylinders, pistons, valve housings or injection system components. Hydraulic and pneumatic components such as valve blocks are also typical areas of application for the new development.

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Automatic generation of scan programs

Metris launches Focus Scan 5.2 software that firmly speeds up the preparation and execution of CMM laser scanning inspection jobs. Automatic scan path programming and virtual point cloud simulation allow users to quickly prepare – off-line or at the CMM – the complete acquisition, analysis and reporting workflow. In this way, Focus software further accelerates every step of the Digital Inspection Process, providing better insight and unparalleled productivity. With Focus Scan 5.2, Metris once again added an important step in realizing its vision of a full Digital Inspection Process, which helps companies revolutionize their entire design-through-manufacturing process. The concept of digitizing samples and running inspection on the digital copies of the samples streamlines metrology operations and embeds them in the CAD-centric development process.

Metris
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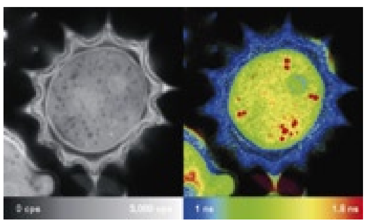
Highly Flexible FLIM and FCS Analyses



Olympus has announced that its FluoView FV1000 confocal laser scanning microscope (cLSM) and FV1000MPE Multiphoton ranges can now be fitted with the PicoQuant module for Fluorescence Lifetime Imaging (FLIM) and Fluorescence Correlation Spectroscopy (FCS). FLIM and FCS are advanced methods for measuring minute changes in fluorescence that occur in cells over very short periods of time. FLIM is often used to accurately determine factors such as: O2, H2O or Ca2+ concentration; intracellular signal transduction; as well as molecular structure and dynamics. FCS applications include: molecular association/dissociation; concentration (fL range); kinetic rate constants; as well as in vitro and in vivo intramolecular dynamics.

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Interview with Michael Engel, CEO Vision Components

INSPECT: Mr. Engel, you are internationally considered the "father" of the Smart Camera. How did you, back then, conceive of this idea, what were your initial goals and have your expectations been fulfilled?

M. Engel: Well, I have been developing digital image processing solutions since the early 1980s. My background is in experimental physics. The industry's need for quick and precise solutions was apparent at that time, so I started to look into industrial applications. The first camera with integrated image processing was created due to this demand by the industry and due to my ambitions as an inventor. That was in 1995. Since then, the tendency stayed the same: to integrate an increasing number of functions into a small space. From the start, I have felt that the application range for our systems is almost unlimited. But there was no way to foresee that my company would become well-established so quickly: by now, we are the leading experts for intelligent camera systems.

What is, from your perspective, the best definition for a Smart Camera and how would you distinguish this from a vision sensor?

M. Engel: A Smart Camera can perform image processing routines autonomously, thus replacing conventional PC systems. Our freely programmable Smart Cameras are optimally suited for industrial applications. They feature an integrated processor and can process images without external intelligence. They easily perform demanding tasks, e.g., in high-speed applications such as in the printing industry. Other typical application areas include quality and completeness checks and code reading. Vision sensors basically use the same technology. Since they are equipped with a limited software package, they can only be parameterized for specific tasks. They generally perform sensor-like functions, such as object recognition, 1D and 2D code reading, and simple color checks.

The cost for industrial-grade PCs is ever decreasing while their performance increases. On top of that, we have seen first steps towards machine vision based on low cost netbooks. Is the concept of the Smart Camera sustainable under the consideration of cost?

M. Engel: Smart Cameras face a bright future in industrial applications. Netbooks, designed for private use, cannot keep up with them in machine vision applications, and neither can industrial workstations. It is vital to consider the demands on the system software. Netbooks and PC solutions use operating systems such as Windows or Linux which are neither crash-proof nor suitable for real-time operation. These, however, are essentials for an industrial system. Real-time capability guarantees that all events are processed within the cycle time. We know office computers to freeze from time to time: while they catch up on tasks that have piled up in the background, they are unavailable for us users. In a production line, in quality control for instance, that would be fatal. During such an overload situation, the control system would not be able to keep up with the machine or would stall altogether. This cannot occur with our systems because all VC Smart Cameras are based on the real-time operating system VCRT. Moreover, the file system is protected against power failure.

Industrial applications pose high demands on the hardware as well. Rugged environments are problematic for solutions with separate computers. Our Smart Cameras are protected by robust housings which makes them virtually maintenance-free. Additionally, their compact design and wide functional range allow for an optimal integration into any production process. To sum it up: PC solutions in general, even compact PC systems as may be envisioned for the future, cannot hold their ground against Smart Cameras which execute all these functions without a separate computer. Sales numbers show that intelligent cameras and vision sensors speedily gain on PC-based solutions.

What is to be expected in further technical development of the Smart Camera within the next five years? What are your plans?

M. Engel: Image processing depends on speed: The quicker images can be detected and processed and the more pixels can be processed per second, the better.

We can now process almost 500 frames per second. Furthermore, we provide intelligent software solutions that we have developed for our customers: our generic image processing library VC Lib and intelligent specialized software packages such as the VC Smart Finder, a program library for contour-based pattern recognition, and the VC Smart Reader, a library for 2D code recognition. Our latest development is the open source library OpenCV. With an eye on 3D technology, we are currently launching the stereo camera, a flexible board camera system. The camera heads can be fitted with a large variety of sensors (with resolutions from 640 x 480 to 1,550 x 1,200 pixel) for different applications in order to cover the broadest possible spectrum of applications.

Vision Components is the second highly successful machine vision company that you have founded, after Engel & Stiefvater GmbH, your first company. What is your formula for success?

M. Engel: That I am doing what I like best – image processing continues to be a fascinating topic. My team shares this attitude and this spirit of research. Our working atmosphere is very pleasant. And else – though that can be practiced in any industry: we develop our solutions so as to optimally fit users' demands. Our Smart Cameras are such a success because they are extremely powerful and very compact. Therefore, I think that focusing on high performance and innovative thinking is the best recipe for economic success.

Mr. Engel, we thank you for this interesting discussion.

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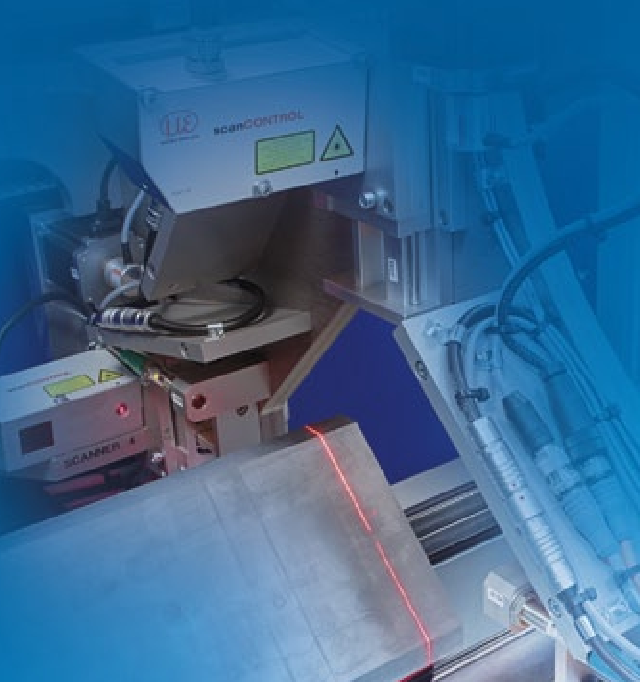

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