VOLUME 10
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VISION › AUTOMATION › CONTROL

INSPECT

Special: Cameras and Frame Grabber

Camera Technology Trend Survey

FireWire or GigE?

Laser, X-Ray, Thermography

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Innovation in Imaging

Women's Power

The daily presence in the media of the top executives of the Dax-listed companies and big concerns is due to their importance for the economy. An exclusively male-dominated presence. And more or less acting in the background we find the medium-sized enterprises – much in contrast to their importance. After all, medium-sized companies comprise about 99.3% of all enterprises subject to turnover tax; companies, in which nearly 68.3% of all social-security taxable employees create 41.2% of the nation's turnover, and in which 68.5% of all apprentices receive their training, according to the Institut für Mittelstandsforschung (ifm) (Institute for small and medium-size business research) of the Mannheim University. And here, we are no longer in a man's world.

An interesting, and long overdue book, published last year by FinanzBuch Verlag, is making the fact clear. Titled "Töchter der deutschen Wirtschaft", Daughters of the German Economy, it is based on a series of articles in the German-language Financial Times Deutschland. I usefully spent my leisurely days during the holiday season browsing and was fascinated by the power displayed by some of the heiresses of German enterprises.

Reading, I met with Bettina Würth of whom her father said, "The place my daughter occupies today is not the place her father put her in." Indeed, she worked the hard way for her ascent to the top. "I worked my way through all the departments," she herself emphasizes. She wanted to show she could do it – in spite of being a daughter.

There is Nicola Leibinger-Kammüller, who enjoys an excellent reputation as head of the engineering company Trumpf. A graduate in literature with a PhD she has been setting the course for Trumpf for two years now. She has succeeded in breaking up once patriarchal structures and introducing a more democratic-style leadership. "Since I'm here," she says, "top managers are called upon to shoulder responsibility and not look upwards for guidance."

Also, I found three examples of female leadership in an industrial sector where you would least expect it, breweries of all places: Veltins, Warsteiner and Privatbrauerei Strate are managed by female executives.

A look at the food sector shows Marli Hoppe-Ritter together with her brother as the driving force at Ritter Sport, a manufacturer of chocolate. She also has established her true passion, art, as a factor at the company's headquarters at Waldenbuch. There, the private Ritter Art Museum saw 160,000 visitors in two years. (Needless to say that living in a neighbouring community I am in the habit of availing myself of this aesthetic treat.)

One of the most influential executive personalities among German independent publishers is Dagmar Sikorski. The Hamburg based Sikorski Group, a music publisher, with its eighteen publishing companies markets the rights of prominent artists and composers. Beside her main position, Sikorski is also president of Deutscher Musikverleger-Verband, the German Music Publishers' Association and acts as a member of the board of directors of GEMA.

This picture of female leadership is rounded off by further well-known names like Helga Breuninger, Kim-Eva Wempe, Isolde Liebherr, Meike Schlecker, amongst others.

However, there is no light without shadows. Sometimes, it's just not enough to be a heiress. Sometimes with fatal results for the company in the long run and with medium-term discontentment amongst the company's employees. Indeed, there have been instances where top executives threw in the towel after a takeover by the heiress. It is, as the saying goes, not all gold that glitters.

The book is on sale at bookstores.

Harald Grobholz

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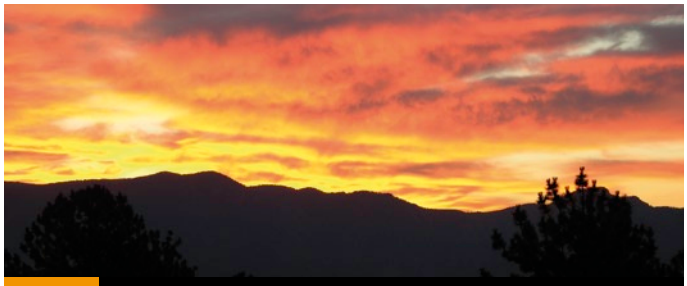

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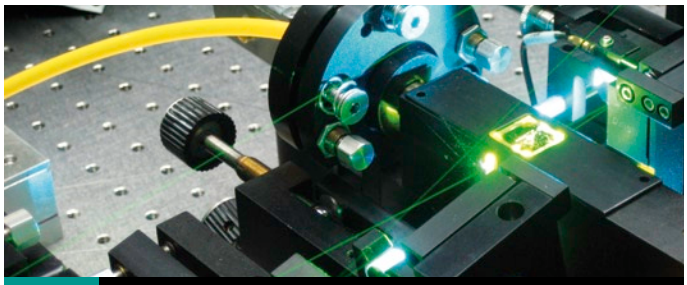

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NEWS

COVER STORY

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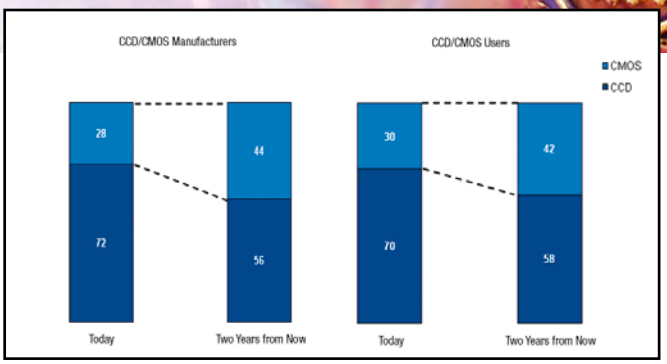
Secrets Unveiled

Technology Trend Survey for Industrial Vision Cameras

Machine Vision market surveys mostly address economic aspects and naturally try to cover all facets and technologies of the field. Single technical aspects can very rarely be looked deeper into for risk of otherwise blasting the survey out of proportion. However, for suppliers and users of vision components and products it is of equally high interest to learn which features are demanded today and which are the trends of the future. For the product class of cameras, which according to the annual EMVA study is at 30 % turnover share the biggest component sub-group for machine vision products, a survey was now conducted to cover these technical aspects. The survey was designed and executed by Framos Imaging Solution, Munich, in close cooperation with the INSPECT.

Two different questionnaires have been compiled for camera users and camera manufacturers respectively, each in German and English language. Due to the significant differences in impact on the vision market that the different participants brought to the table, the number of employed or produced cameras was taken as a weighting factor. The higher the number of cameras has been stated, the bigger the impact of the individual answer in light of the total result. In order to avoid statistical distortion of the study, the top 5 %, i.e. the biggest producers and users, were taken out of the evaluation. In addition, only questionnaires were accepted for the evaluation where the participant took at least five minutes time to completely answer all questions. Only then could the input be evaluated seriously.

In total 532 questionnaires have been completed and returned. However, for 266 of those the completion was done in less than five minutes so that in the end a total of 266 questionnaires were accepted for evaluation. From these 83 participants are producers and 183 participants are users of industrial camera technology. After deducting the top 5 % 75 producers and 170 users remained. That means that after taking care of all distorting factors there was still a good number of questionnaires to evaluate so that the study does have a reasonable good statistical relevance.



Distribution of CCD and CMOS cameras today and in two years time

The producers covered in the survey manufactured between one and 800,000 cameras in 2008. The users named numbers of cameras employed between one and 30,000 during the same period.

After deduction of the top 5 % numbers of up to100,000 produced and 2,000 employed cameras remained for 2008. On average the participating manufacturers produced 5,330 cameras mainly for the areas of security (45 %) and industry (32 %), whereas the participating users on average employed 97 cameras mainly for applications in industry (67 %) and security (13 %).

CCD or CMOS

Questioned about the percentage of CCD chips and CMOS chips, respectively, in the used or sold cameras today and in two years time, both producers and users expect a significant shift towards the CMOS technology. Currently 28 % of cameras sold, are CMOS cameras, 72 % are CCD-based cameras. In two years time the manufacturers expect an increase by 16 % to 44 % of CMOS cameras.

The users currently utilize 30 % CMOS cameras as opposed to 70 % CCD cameras. An increase by 12 % to a ratio of 42 % CMOS cameras is expected within the next two years. Consequently, the users expect that there will still be a share of 52 % of CCD cameras put into use in 2010.

Trend towards Color

The distribution between monochrome and color cameras has been at 38 % color cameras and 62 % monochrome cameras in 2007 on the manufacturer's side. For the users this was somewhat similar at 35 % for color cameras and 65 % for monochrome cameras. Supply and demand were very well in synch.

In 2008 the result is very similar for the camera users: 35% color cameras and 65% monochrome cameras. On the camera manufacturer side, however, a significant increase of 13% up to 51% of color cameras can be noticed and the matching decrease down to 49% of monochrome cameras.

It remains to be seen if this result shows an early anticipation of upcoming market demands or if the need for color information in machine vision might be overestimated by the suppliers.

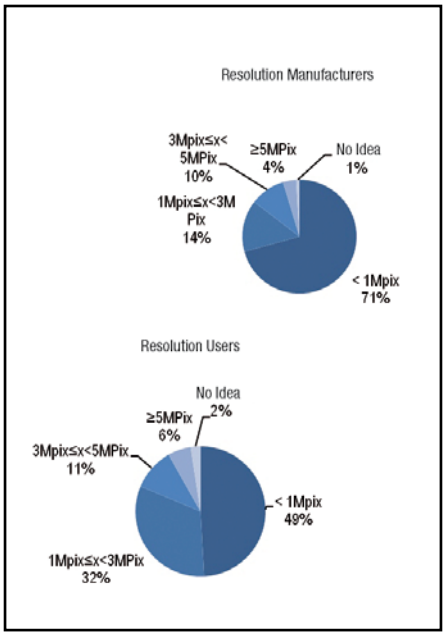
Mega-Mega-Pixel

The higher the camera resolution the higher the data density, the more accurate the data analysis, the "better" the result. High resolution has its price, though, in several aspects. Not only the camera price itself goes up, but also the requirements for the optical lens, for the computing power of the processor and the data transfer rate of the interfaces. So what will the future bring? More and more Mega pixels, as can be seen in the consumer markets?

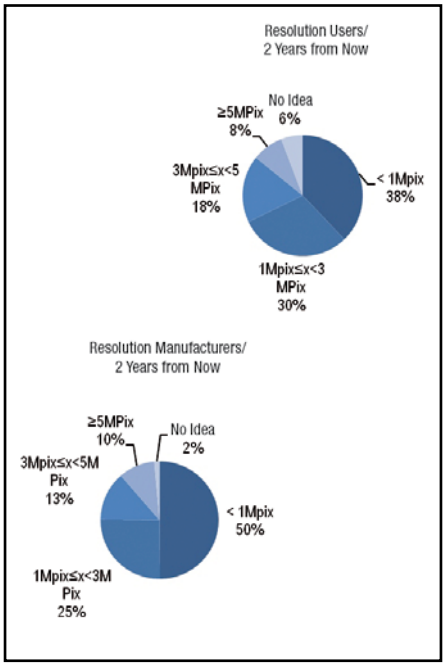
The camera manufacturers declared within the survey that 71% of their products today belong to the class below 1 Megapixel, 14% are between 1 and 3 Mpix, 10% in the 3–5 Mpix range and 4% are in the high resolution class of more than 5 Mpix.

For the users the distribution differs somewhat with 49% below 1 Megapixel, 32% between 1 and 3 Mpix, 11% in the 3–5 Mpix class and 6% above 5 Mpix. Despite the differences, supply and demand are still reasonably well aligned.

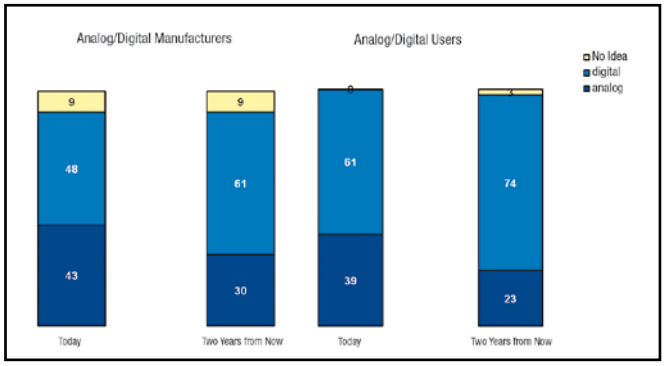
In two years time the camera manufacturers expect the current situation to change toward: <1 Megapixel at 50%, 1–3 Mpix at 25%, 3–5 Mpix at 13% and >5 Mpix at 10%. 2% of the producers did not answer this question.



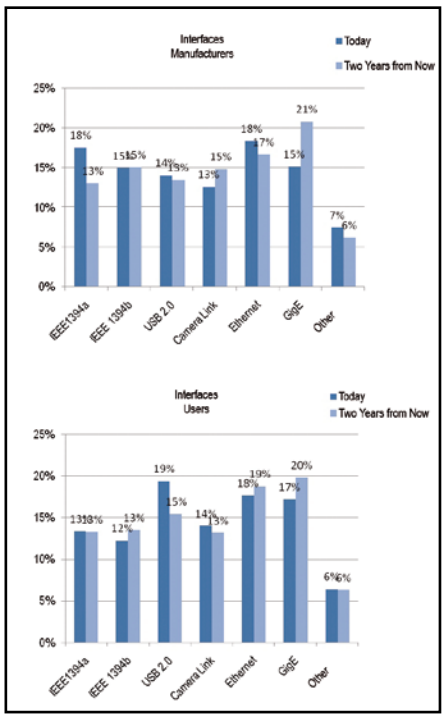
Manufactured/deployed camera distribution by resolution



Two-year projection for the distribution of camera resolution



Shares of analog and digital cameras at manufacturers/users



Priority distribution of current camera interfaces

The camera users indicated the following distribution of camera resolution for 2010: below 1 Mpix at 38 %, 1–3 Mpix at 30 %, 3–5 Mpix at 18 % and > 5 Mpix at 8 %. 2 % of the participants did not answer this question.

In summary the manufacturers expect a stronger trend towards resolution below 1 Mpix than is planned by the users from today's point of view. Part of the reason for this discrepancy is most likely the fact that the percentage of users from industry are significantly higher in this study than the percentage of users from the security area, which is not the case with the participating manufacturers.

The Eulogy for Analog?

Analog technology is dead, is only a relic from history; only legacy machines where modernization is not profitable enough feature analog cameras. This is one point of view.

(Almost) as often, one can hear the following: we are facing years and years with analog cameras still having a good percentage of the market. The price/performance ratio is unbeatable.

What now did the surveyed companies had to say to this question?

Today 43 % of produced cameras are analog cameras, 48 % are digital. 9 % of the manufacturers made no declaration. The producers expect a decrease of analog cameras by 13 % within the next two years. This leads to a forecast of a 61 % portion of digital cameras in 2010.

The surveyed users already employ at 61 % considerably more digital than analog cameras. They expect an increase by 13 % to 74 % in total for 2010.

… and the Interface

The topic most often and most heatedly discussed at trade shows and technical conferences is the camera interface. We asked producers and users of camera technology for their ranking among the current interfaces.

Looking at the answers, only the prognosis for the future provides a homogenous picture. The priorities for the current assessment by the manufacturers are as follows: Ethernet, Firewire a, GigE, Firewire b, USB2.0, CameraLink. The outlook for 2010 changes that ranking to: GigE, Ethernet, Firewire b, CameraLink, USB, Firewire a.

From the users point of view a different prioritization could be seen for today: USB 2.0, Ethernet, GigE, CameraLink, Firewire a, Firewire b. In two years time this picture changes, however, also to: GigE, Ethernet, USB 2.0, Firewire b, Firewire a und CameraLink.

Both groups see a clear trend towards the GigE camera interface.

Last but Not Least …

… there is always the question of how to choose from the abundant supply of different cameras. Which are the aspects the suppliers put special emphasis upon in order to convince with their product range and which criteria are relevant for the customer decision? And are both aspects in line?

In answer of the question „Please list your top five criteria in the camera selection" manufacturers and users named the following features:

Manufacturer	User
Framerate	Price
Resolution	Resolution
Signal-to-Noise Ratio	Framerate
Light Sensitivity	Interface
Size/Mounting Form	Size/Mounting Form

Within our short summary we could only cover a small portion of the market study results. The complete evaluation and thus also data regarding frame rates, read-out technologies, optical mounts and sensor formats, but also regarding the future development of smart cameras and the expected pricing for cameras, have been provided exclusively to the participants of this study as a thank you for the time they took and the valuable data they provided.

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Kann alles.

Kann noch viel mehr.

Machine Vision ist nicht mehr das, was es einmal war. Und die besten Kameras von heute sind nicht, was sie demnächst einmal sein werden. Die STINGRAY von Allied Vision Technologies beispielsweise ist als variable Transformer-Kamera konzipiert, passt sich jeder denkbaren Herausforderung an und hat mit ihren intelligenten, programmierbaren Verarbeitungsfunktionen die Zukunft bereits eingebaut: Was die STINGRAY können soll, bringen Sie ihr ganz schnell bei.
www.alliedvisiontec.de

SEEING IS BELIEVING

Opto Sonderbedarf Opens French Office

Since the 1st December 2008, the recently founded company Opto France became fully operational. Established in the Rhone Alpes region, at the Parc Altais Galileo facility in Chavanod, Opto France enjoys a strategic location close to the town of Annecy and within easy reach of Lyon and Grenoble. The business is led by Patrick Trannois, who brings with him more than 20 years experience in scientific imaging & machine vision. This new, local office will enable the company to offer a dedicated approach to the French market, further enhancing the service to its expanding international customer base. Opto France offers the full core capabilities of the group, focusing on the distribution of the solino product lines as well as offering the fully customized OEM solutions.

www.opto-france.com • *www.solino.com*

LMI Signs Distribution Agreement

LMI Technologies (LMI) has signed a distribution agreement with Japan F.A. Systems Corporation (JFAS) to initiate a new added sales value channel in Japan for LMI's maestro, HexSight and FireSync product lines. LMI has an office in Goteborg, Sweden and Heerlen, The Netherlands. When asked why JFAS selected LMI as a new supplier, Mr. Naoyuki Kani, CEO of JFAS noted that, "both LMI and JFAS share similar business ethics. We both place a lot of energy on providing the best customer service." Kani has a 20-year relationship with his current partners in the machine vision industry and LMI has 30 years of technical know-how in vision sensor technology. Together they look forward to opening up new opportunities for LMI applied technology and JFAS services in Japan.

www.lmitechnologies.com • *www.jfas.co.jp*

e2v: Distribution Agreement with Atlantek

e2v announced the signing of a new distribution agreement with Atlantek Vision Pty, for its industrial line scan inspection cameras into Australia and New Zealand. This distribution agreement with Atlantek Vision Pty, a leading vision technology specialist based in Australia, will enable e2v to further strengthen its presence in the Asia Pacific region. With over 20 years experience in Australian vision industries, the company will support and distribute e2v's line scan CCD camera portfolio, including the complete AViiVA camera family that features sensors of 512 to 12,288 pixels, and the newly launched multi-line sensor EliiXA cameras. Atlantek's extensive market knowledge and service facilities, combined with e2v's superior range of Aviiva and Eliixa cameras and sensors, will deliver an unbeatable package of machine vision know-how and technology to the Australian and New Zealand machine vision markets.

www.e2v.com • *www.atlantek.com.au*

New International Regional Sales Manager

Navitar announced the appointment of Patrick Buvé as Regional Sales Manager for Europe, Middle East and Africa. Buvé will be based in Belgium and will oversee Navitar staff in Germany and the United Kingdom. Together they will focus on new business development and client retention throughout Europe. Buvé joins the company with over fifteen years of experience in the Machine Vision industry. Prior to joining Navitar, Patrick was the European Sales Manager for CCS Europe, where he managed multiple sales channels consisting of OEM, machine vision partners and distributors. He worked closely with customers and company engineers to develop customized solutions according to the customer's requirements and handled key OEM accounts.

www.navitar.com

Isra Vision: Forecasts Confirmed

The company met all of its targets for revenue and earnings for the 2007/2008 financial year (30th September), and even succeeded in surpassing them. The group revenue from the preliminary annual financial statement increased by 33 % to €68.3 million. The total output increased by 30 % to €76.3 million. The gross margin remained steady at 58 % of the total output; relative to the revenue, this margin increased by one percent to 52 %. ISRA has now broadly completed the integration of its extensive acquisitions. Synergies can be seen in all indicators related to profitability. The EBITDA rose by 70 % to €18.6 million. The EBITDA margin grew by five percentage points to 24 % of the total output and 27 % of the revenue. The EBIT more than doubled, increasing to €12.9 million. The EBIT margin increased by seven percentage points to 17 % of the total output and 19 % of the revenue.

www.isravision.com

Aicon Opens Office in Korea

Whether in Japan, China, Korea, Malaysia or India – Aicon successfully captures the Asian market. In order to handle requests from this region more efficiently, the company has recently opened a liaison office in Seoul (Korea). The office is managed by Jonathan Kwon who has already gained wide experience in the area of optical metrology for several years. He supports the Asian distribution partners with respect to all technical and commercial issues. Dr. Carl-Thomas Schneider, Aicon's president, comments this step as follows: "By opening this liaison office, we can much better cope with our growing sales activities in Asia. Now we are in the position to meet our customers and distribution partners on-site within a very short time. Moreover, Mr. Kwon speaks Korean and Japanese next to English, which eliminates many communication problems."

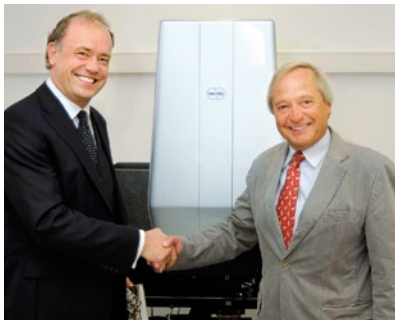
www.aicon3d.com

New Vice President Will Serve European Operations

Dr. Thomas Kessler has joined Edmund Optics as Vice President European Operations, operating from the company's offices in Karlsruhe, Germany. He will be responsible for all sales and distribution operations of the company in Europe. Kessler will direct the overall coordination of all aspects of sales, marketing, service, technical support, inventory, distribution, product development, supplier relations, finance and organizational development of the company in Europe. For the past 13 years, Kessler served with Schott in Mainz, Germany having most recently served as director of product management, sales, marketing and supply chain for its Advanced Optics business.

www.edmundoptics.de

3D Fiber Probe Project Completion



In November 2008 a meeting took place at the Physikalisch-Technische Bundesanstalt (PTB – National Metrology Institute) between the president of the PTB, the managing director of Werth Messtechnik, and the project teams of both organizations, to conclude the 3D Fiber Probe development project. 10 years of cooperation in the area of microprobes for multisensor coordinate measuring machines were brought to a successful conclusion. In the course of the event, a high-precision VideoCheck multisensor coordinate measuring machine from the Werth company was accepted by the PTB. Both agreed to continue their cooperation in the future. Their emphasis will be on the area of optical 3D sensors for micro-applications, and aspects of multisensors and especially questions of traceability and accuracy will be addressed.

www.werthmesstechnik.de

New Vice President Service at Viscom

Henning Obloch has assumed leadership of the Service business unit at Viscom. With his arrival, Viscom is quite pleased to have been able to gain such a proven expert in the field of electronics production. One of his primary responsibilities will be optimizing training for the service technicians, to further increase the efficiency of service calls to the customer. He will also direct the development of market-oriented service offerings, maintenance contracts and service call planning. Since 1989, Henning Obloch has been at home in the SMT industry. He draws on 14 years professional experience in Service and Sales at Panasonic Factory Automation, Hamburg, to support his new position here. Afterwards he posted three years as General Manager, Sales for Rehm Thermal Systems in Blaubeuren.

www.viscom.de

INSPECT

INSPECT Goes International

Did you notice on our front cover? The INSPECT is in its tenth year of trade journal existence. In one year from now we are going to celebrate the completion of the first decade of INSPECT.

But already today we have reason to rejoice. Quite contrary to the general economic outlook we decided for a growth strategy. So join us in looking forward to ten instead of five issues of INSPECT this year. These are 10 issues filled with cutting-edge, extensive and especially for your fields of interest researched information. With the adoption of machine vision and optical metrology your company will be well prepared for the challenges of 2009. And the INSPECT will support you in this task.

That is not all, though. Not only did we double the number of issues, we also go international. In addition to the German version of the INSPECT, many of you are already used to for years, you are now looking at the first English language ePaper version. From now on, and in addition to the German printed version, each INSPECT will be available in English language at our website www.inspect-online.com and is emailed globally to a couple of thousands of subscribers already.

From the North Cape to the Cape of Good Hope, from Brazil to Indonesia: INSPECT.

It's All a Matter of Position

5 MPixel USB Cameras Support Precision Work in Laser Technology

Using light as a tool? This idea would have been hard to imagine only 20 years ago. Laser technology today continually opens up new application areas as it increases the efficiency, flexibility and environmental compatibility of many production processes. An example is the permanent, non-contact marking of components. Lasertechnologie Winter GmbH, the oldest laser technology company in North Rhine Westphalia, Germany, develops and produces machinery for laser-assisted precision processing and metrology. An important application area for their products is the laser engraving and ablation of automotive components. To ensure the perfectly accurate positioning of the markings, Lasertechnologie Winter has developed a special software that leverages the advantages of the uEye USB cameras from IDS in combination with elements from the Halcon image processing library.

The Germany-based laser specialist Lasertechnologie Winter is a pioneer in the deployment of laser technology. With their innovative systems the company has been a prime mover particularly in the automotive industry, where they have significantly increased the productivity and creative options in the manufacture of control elements. An important application area for Winter's laser technology is the marking of dashboard switches in the Day-and-Night Design.

Dashboard switches were previously manufactured using multi-component synthetic material in different colors, with dark-colored materials molded around light-colored ones. This method was not only labor and time intensive, but also lacked the necessary flexibility. Already in the late 1980s Winter therefore started developing a laser-based solution for marking rear-illuminated switches. In this process, blank parts made from translucent synthetic material are coated with an opaque lacquer in a color matching the vehicle's interior. The laser removes the lacquer layer where necessary, revealing the translucent material in any desired shape such as numbers, symbols, scales, etc. Using a similar process, control elements can even be illuminated in color. For this purpose an additional colored layer, e.g. in red or blue, is applied between the blank part and the topmost opaque lacquer layer. This method is used particularly for air-conditioning or heating controls.

Precise Positioning Guarantees Quality

The quality of the laser marking greatly depends on a uniform contour width and on the exact positioning of the marking. As the human eye can detect even tiny deviations, slight inaccuracies in the marking would substantially reduce the quality of the component. Manual positioning is therefore out of the question: Not only is it too inaccurate and time-consuming, it would also require special adjustment tools. A high reject rate and the fact that only few parts can be manufactured simultaneously are further drawbacks.

Lasertechnologie Winter masters this challenge with the aid of a cutting-edge

5 megapixel resolution and yet very compact: the USB camera from IDS

machine vision solution. High-resolution cameras determine the exact location of each blank part and precisely position the marking according to the defined data. The camera serves as the system's eye and provides the image data necessary for adjusting the laser beam. From this data the specially developed WinOptiX software, which uses elements of the Halcon image processing library, determines the exact position of the components. The interaction between the system's individual constituents – laser, software and camera – is perfectly synchronized and self-calibrating.

The camera plays a key part in this solution. The requirements specification stipulated a high resolution, a very compact design, easy connectivity and flexible integration. Winter opted for the uEye cameras from the German machine vision specialist IDS and chose the uEye UI-1480-C model, which features 2,560 x 1,920 pixels resolution, CMOS sensor, rolling shutter and USB interface.

Key Component Camera

Despite its high resolution the camera is ultra-compact. Only 34 x 32 x 27.4 mm in size and weighing just 62 g, the camera is nevertheless fully featured. A C-mount lens connection, an external trigger input and a digital output leave almost no wish unfulfilled. The camera is also among the fastest in its class: Up to six frames per second are possible in high-resolution full frame mode. With double subsampling the camera achieves 19 frames per second at a resolution of 1.3 megapixels – ideal for a quick preview.

The USB interface ensures simple connection to a PC. The powerful software package complete with software development kit is the same for all models of the uEye range and is included in delivery. Besides flexible tools and demo programs for easy configuration it provides drivers for Windows and Linux.

Whether it's USB or GigE – all uEye camera models from IDS use the same software driver kit, which ensures easy integration

Integrated Automated Quality Control

The large workspace of the laser marking system allows processing several components at the same time. All that needs to be done is load the blank parts on carriers and place them loosely in the machine. The exact positioning is done automatically by camera and software. The system is thus both very tolerant and highly accurate. The marking process is logged from beginning to end and is immediately followed by an automatic quality check (size, contrast, position). This eliminates the need for visual checks by the operator, which are also more time-consuming and less exact. To allow subsequent quality and production analyses, all data is automatically stored in a SQL database.

The solution from Lasertechnologie Winter can also be integrated with older laser systems and allows smooth upgrading.

USB or GigE: Two Interfaces – One Driver

With way over 100 different models in a vast variety of configurations the uEye camera range from IDS offers the ideal solution for almost any industrial or non-industrial application. The product portfolio features cameras with USB or Gigabit Ethernet interface, plastic or metal housing, CCD or CMOS sensor, and resolutions from VGA to 5 megapixels. And if any wishes still remain unfulfilled, IDS can develop and manufacture special customized and project-related solutions beyond the standard.

Whichever variant the customer chooses – they all have one thing in common: the same software package and driver. Integrating the camera with the existing application or changing from one model to another couldn't be simpler.

Every camera comes with free software for the current Windows operating systems and Linux. It comprises, for example, a software development kit (SDK) with image acquisition demos, including the source code in C/C++. Developers can quickly adapt the source code to the specific requirements and integrate it into their own programs. The software package additionally features a TWAIN driver, an ActiveX component and a DirectShow (WDM) driver for the users of standard software solutions. Also available are direct interfaces for many other current machine vision programs, such as ActivVision Tools, Common Vision Blox, Halcon, NeuroCheck or LabView.

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Having an Edge

Image Processing Basics: Edge Detection

Extracting quantitative features of objects from a scene is one of the major tasks in industrial image processing: the diameter and the position of a hole are typical examples. Best practice yields images with good grey-level contrast between objects and background, and the objects clearly show up due to their prominent edges. This article describes some simple methods for edge detection.

Contours in Binary Images

When images are grabbed by properly designed acquisition systems, grey levels of objects are substantially different from grey levels in the background. Objects and background can thus easily be differentiated by a single threshold. Pixels with grey levels below the threshold are set to zero, all the other pixels to 255, resulting in a binary image. The image is now beautifully segmented into two classes, background and objects. Edges, however, are not yet detected, although this special task may well be a crucial step in image processing. Decoding barcode patterns, for instance, is based on the determination of the positions of the edges of dark and bright regions. The various methods of Hough transform usually are applied to edge images with well prepared edges, preferably thinned to a width of a single pixel. Generally, edges are at the heart of image processing as a field of metrology: edges are local differences in contrast, showing up in the image due to proper lighting of the scene.

A well-prepared raw image and the subsequent extraction of edges are shown in figure 1. The source image can simply be segmented with a single constant grey level threshold. The next step, labeling, is an analysis of the neighborhood relations between pixels. The result is not only a well-defined relation between every pixel in the foreground and a group of connected pixels ("blob", in this case six separated objects), but also the identification of the so-called contour pixels, thus the edges of the objects. The labeling algorithm yields these results on the fly: contour pixels are object pixels with grey level 255 like any other object pixel, but they can easily be differentiated from inner pixels, since they are connected to the background. Labeling and highlighting only the contour pixels of the blobs in the resulting image turns out to be a proper method of edge detection in binary images. A similar approach is to extract a chain code for the contour of binary objects, based on contour tracing, which directly features the edges in an image.

Search Lines

Labeling and contour tracing are used in most image processing libraries, but they are by no means trivial. Every labeling algorithm first has to detect an object in the image. For this purpose, the binary image is checked line by line from the upper left to the lower right corner, and the grey level of every pixel is checked. The first pixel encountered with grey level 255 belongs to an object and necessarily is a contour pixel, thus is part of an edge. This simple, very efficient method of edge detection is widely used in industrial applications. It is immediately clear that search lines from the left, the right, from the top and from the bottom sides of the image will touch the adjacent con-

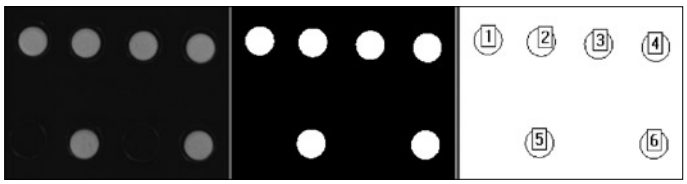

Fig.1: Grey level image, binary image and label image showing the contour

tour pixels. Search lines yield good results, whenever the position of an edge is roughly known, whereas the exact position and orientation may vary due to the characteristics of the handling system for the parts under investigation. Edges of this type are "caught" by use of search lines in predetermined regions of interest. Although a single search line might be sufficient in some cases, it is worthwhile to use several parallel, only closely separated search lines, checking for consistency to be one the safe side. An alternative approach might be to average the signals of several lines to eliminate noise or artifacts. In general, search lines are a very efficient method for edge detection, whenever certain information about the structure of the scene exists, much more efficient than labeling, which is based on the analysis of the whole image rather than single lines. A refinement of the use of simple search lines along the x- and y-axis only are search arrows, probing a ROI from several directions, possibly pointing to or emerging from a common center, to check the compactness of a hole, for instance.

Search Lines in Grey Level Images

When implementing a search line in software, you will immediately try to apply the idea directly to grey level images. It makes no sense at all to create a binary image and just look for the first white pixel on a line; it is much easier to take the grey levels from the line, check for the first pixel with a grey level above the threshold and stop searching, since the edge is already detected. The next step in the evolution of your method may be to get rid of the global threshold; why not just look at the difference between the grey levels of two adjacent pixels in the line? Once this difference is above a certain threshold, the edge will clearly be segmented from the background, and that is all you want to see! This works fine, and even inhomogeneous lighting or deviations from a flat optical field will have no significant influence on the result, since only the local (and not the global) differences in grey level between background and object are probed. Signals must not be in saturation or near to darkness, of course, and the threshold for the grey level difference has to exceed the noise level clearly. Apart from these restrictions, this method of edge detection is fairly robust, being a differential method based on the evaluation of the local contrast.

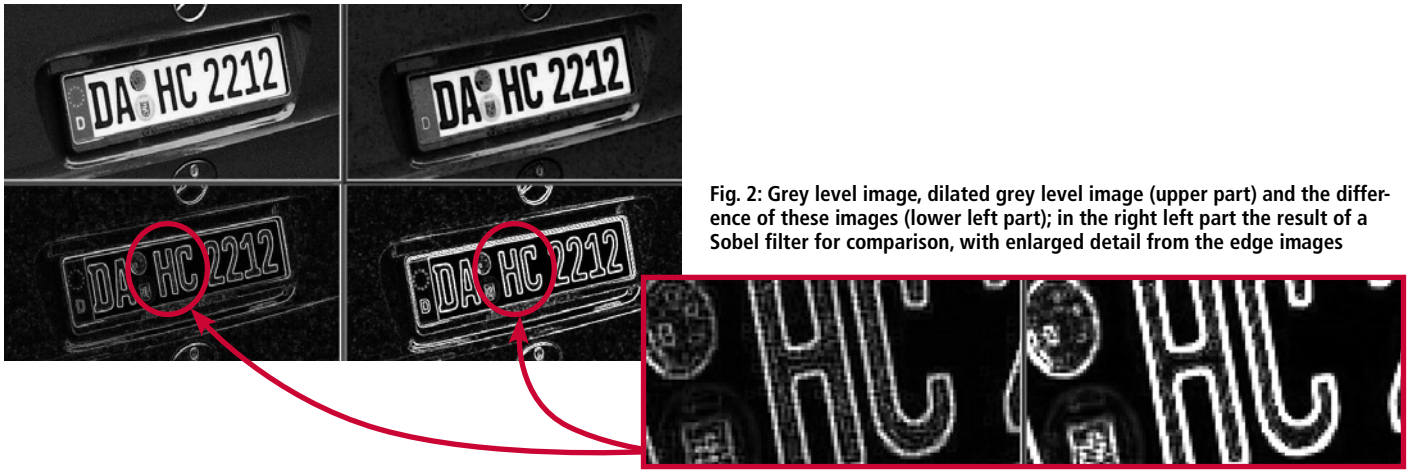

Fig. 2: Grey level image, dilated grey level image (upper part) and the difference of these images (lower left part); in the right left part the result of a Sobel filter for comparison, with enlarged detail from the edge images

A systematic approach along these lines of thought directly leads to the idea of the classical edge filter. Every mathematician in his original right mind, not yet spoilt by the strange ideas of engineers and the rude methods of physicists, will immediately see an edge as a region of rising or falling of a grey level function, the position of the edge given by the maximum of the derivative of said function, the derivate being approximated on the discrete grid of pixels on a 2D-plane by a difference-quotient. Indeed, the simple difference between the grey levels of adjacent pixels on a line (parallel to the x-axis, e.g.) is nothing else but the most primitive, crude and dirty implementation of the first derivative along that line (there are much better versions, of course). In order to make sure that edges are found independent of their orientation in the image, possibly with the same probability and even without shifting their gracious position, filters have to be carefully constructed. The absolute value of the gradient-vector roughly does the job. It may be plotted as the grey level in a resulting image, showing edges as bright areas and regions with slowly varying intensity as dark areas. Edge filters are broadly dealt with and very well documented in the literature [1, 2]. We shall not dare to touch them any more in this article.

Thinning

A typical result of an edge filter applied to an image is shown in figure 2 on the lower right hand side. This operation was a so-called Sobel filter, which is a clever combination of computing a derivative in one direction and of averaging the signals in the perpendicular direction, all within a single scan of the image. The edges are clearly visible as bright regions. The Sobel filter apparently does a good job in isolating the general region of an edge as a zone with a width of several pixels. To find the unique position of the edge, however, the edge image has to undergo further image processing. This is a well-known problem with edge filters. Although post-processing is possible, of course (looking for local maxima in the edge image, e.g.), further operations will consume valuable computing power and have to be robust, at least in industrial applications. Methods which directly result in edges thinned to a width of a single pixel, would probably have a valuable advantage. For binary images, there exist some reliable mechanisms of this kind. An example is shown in figure 3. A so-called dilation was applied to the binary source, resulting in objects which have a line of single additional pixels around their contour. In the next step, the difference between the source and the dilated image is computed, resulting in an image with the contour as the single remaining feature, depicted as a chain of single white pixels like pearls on a string. Dilation can also be applied to grey level images; this operation, however, does not only build up a single pixel along the edges. The difference image calculated by means of this procedure is quite similar to the result of a typical edge filter, as can be seen in figure 2, detail. In general, dilation is a rank filter and consumes a lot of computing power. If filter operations are definitely a no-go, you might try to simply shift the whole image by one pixel to the left and to the bottom and look at the results of the Boolean operations between the source and the shifted image. That can be really fast!

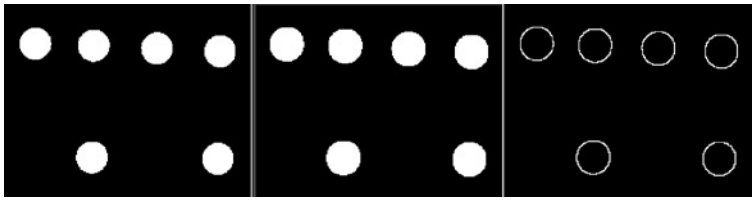

Fig. 3: Binary image, dilated binary image and the difference of these images

Conclusion

Thinned edge images can easily be computed with binary sources by labeling, contour tracing or by means of search lines. An alternative approach is to use a dilated image, subtracted from the binary source; this operation directly yields a thinned edge image. Edges in grey level images may be found by search lines and analysis of the slope of the grey level function along the line. This method gives good results, when the position and orientation of the edge is roughly known. Generalized methods have to make use of edge filters. After these operations, edges appear as bright bands, which usually have to be thinned with further image processing algorithms.

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VIEWPOINT

Crisis Management

Financial crisis, recession, economic uncertainty – the consequence: lay-offs. Is that the necessary, sensible, businesswise responsible decision?

Daimler, Opel, Arcelor, SAP, but also Google and Microsoft lay off their employees. For the United States the biggest reduction of jobs since 1945 is already forecasted.

Costs need to be cut in difficult times, the belt needs to be tightened. The company as a whole needs to be protected, last but not least in the interest of the majority of employees (which were not let go). This is the usual and also the ethical correct argumentation. But is it economically sound? Is the short-term benefit really bigger than the potential damage?

Reducing costs, shedding cushions accumulated in fat years, making the company lean and agile, is not a bad idea, generally speaking. It might have been more clever, though, to accomplish that already during the good times and thus be better armed for the upcoming difficult months. But: Better late than never!, as the saying goes. Now it is up to the smart company leader to decide where the dispensable costs are located.

In our companies from the "developed countries" the block of labor cost ranges very highly in the cost categories. That makes cost cutting here so attractive. However, one of the reasons for this is the fact that our people are so highly qualified. They bring exactly the skill set to the table that is not only required for their demanding tasks – all other tasks are long since outsourced anyway –, but that was build up and financed heavily by the companies themselves. All the investments in these so called human resources – intensive recruiting, tedious selection processes, company internal training, additional education, specialization – are lost with the lay-off. As well as the know how of the people about the products, markets, competition, internal processes of their company. That is first and foremost a bleeding. Bloodletting was common practice in the middle-ages and was prescribed almost always no matter what the ailment was, but today we know that this leads more often than not to the early demise of the patient instead of his recovery. This is the danger that also the company faces when reacting to experienced or expected difficulties foremost with lay-offs and thus with decimation of their own strength.

A diet for the company can be reasonable, with love-handles too prominent fast movements are becoming difficult. But "lean" must not turn into anorexia. To hold one's ground, not only but especially in times of crisis, requires strength. Strength in innovation capability to bind the customers to the company by better, not cheaper, products and services. Strength not to lose sight of the long-term strategic goals and thus stay a reliable partner for the customers. Strength to develop new markets, products and sales channels, i.e. to conquer the recession in the old markets with investment into new ones. Investment into the future in addition to coping with the not so easy presence is only possible with qualified and motivated people on board. A team that is spread too thin is lacking both, power and creativity.

BTW future. All current doom saying put aside: the recession ultimately will end, there will be a rebound. First signs for this rebound are expected by the experts around mid 2009. In most European countries, with the respective labor laws, this will be about the time when the employees given notice today will actually leave the company. The necessary resources then required, will need to be searched for, found and trained and it will take quite some time before they can be as proficient as the experienced staff from the past.

Would it not be better to rise with the economic upturn with innovations, improved products and processes and motivated people on board, empowered by their own company?

This, in any case, is my point of view.

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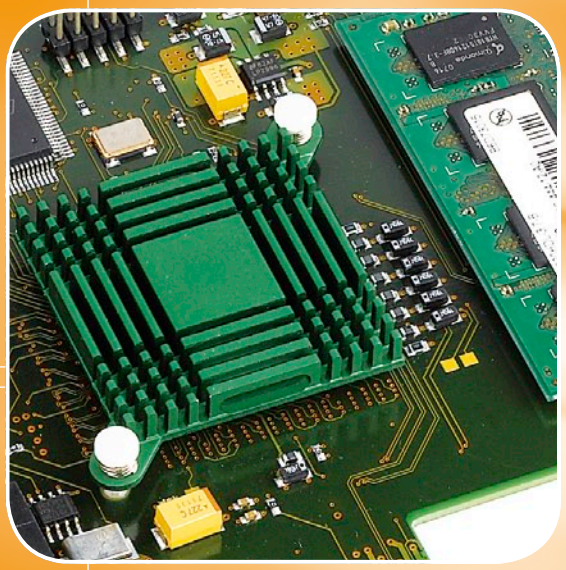
Inspect

Vision



Eltec Elektronik AG is headquartered in Mainz, Germany, and offers targeted system solutions based on powerful hardware and software products for the automation, telecommunications, medical technology, security and transportation technology markets. The enterprise's extensive product portfolio comprises CPU boards, frame grabbers, I/O products, imaging solutions, software and complete systems. Eltec is a CE and ISO 9000 quality standard certified production site and ships well over 10,000 specifically developed boards to renowned customers around the world every year. A team of experts is on hand to render support in the development of customized solutions.

ELTEC systems

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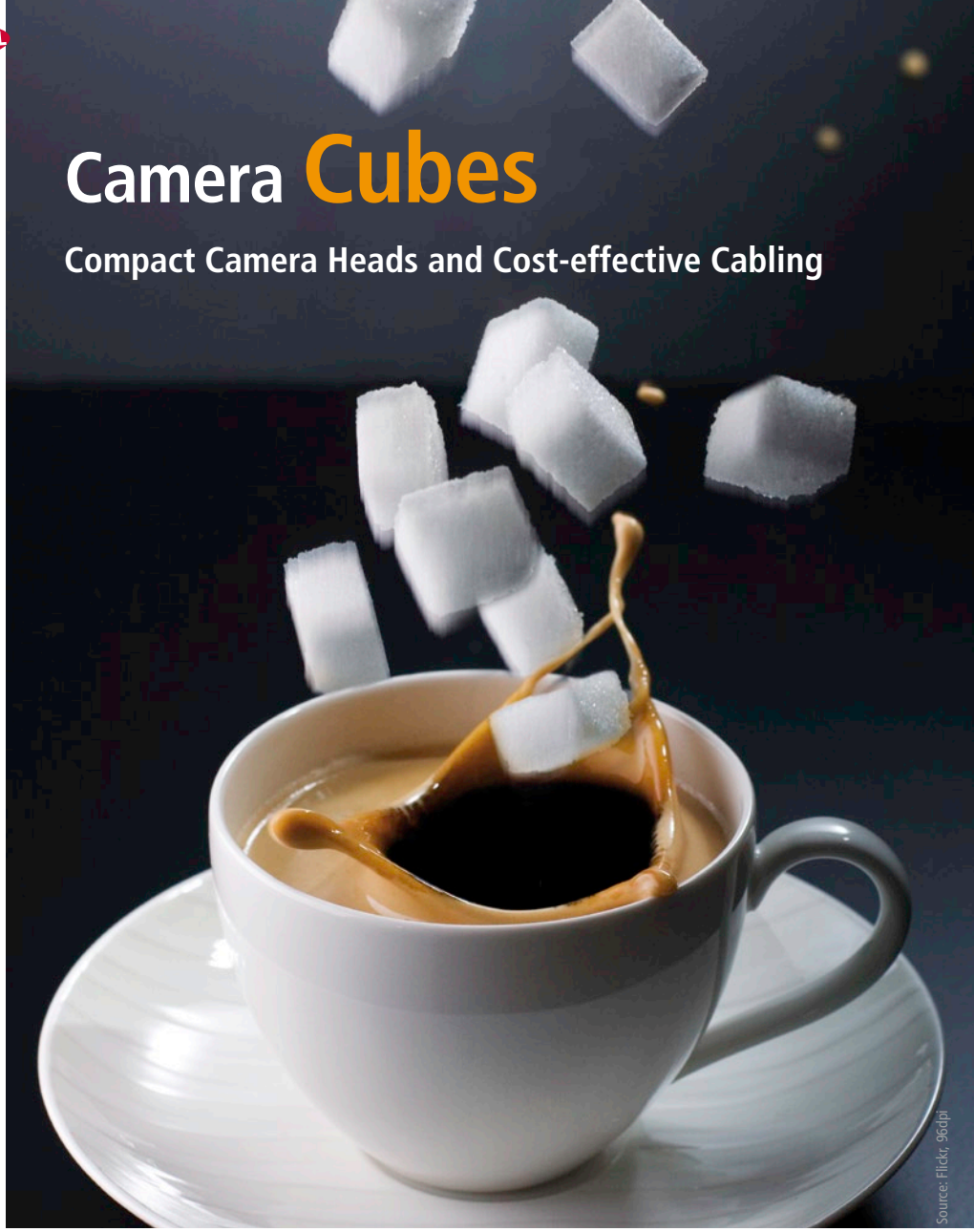
Camera Cubes

Compact Camera Heads and Cost-effective Cabling

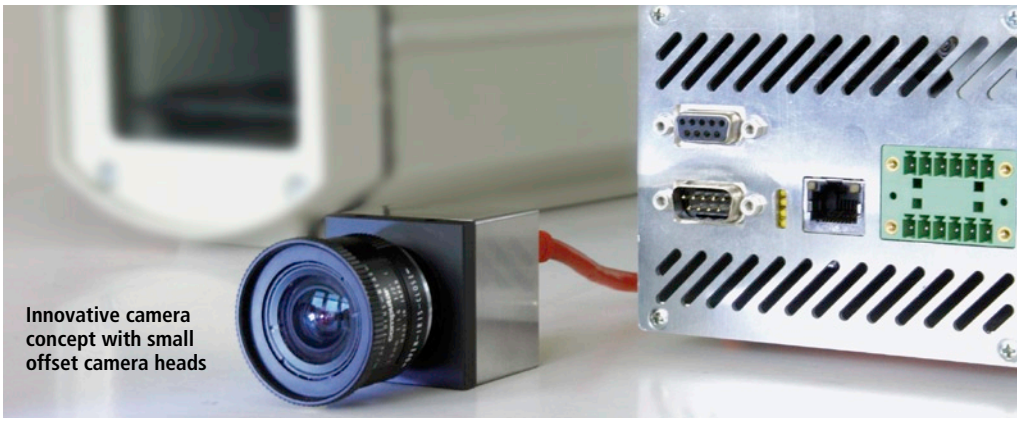


An intelligent camera that is as tiny as a sugar cube and has the computer power of a Core2Duo in a fashionable black housing – sounds good, but unfortunately such a camera is still a figment of our imagination today. Nonetheless, even those of us who could live with a camera that may not be the size of a sugar cube but one that is actually about the size of a package of sugar, would want this camera to have heads that are as small and compact as possible, even if they cannot be shrunk down to the size of a sugar cube either. In such an application, the computer cube would be set up several meters from the camera cubes and would actually be equipped with a dual core CPU. Eltec now offers an innovative camera concept boasting a flexible and scalable image processing solution that meets virtually every expectation.

It is a common phenomenon for innovative concepts to arise from challenges. In the case in point, Eltec was working on a project that involved the development of a successor for a small intelligent camera that had become too slow for today's applications due to its limited computer speed. The objective was to come up with an intelligent camera that substantially boosts data speeds as a result of increased performance and that is still compact enough to fit into a weather guard housing. However, after having been customized for the special requirements of the application, this successor model turned out very differently. It now has up to two offset cameras, utilizes an innovative cable concept for digital image transfer and performs computations with the assistance of a Geode CPU on an ETX module. Despite all of these extras it still fits into the weather guard housing.

CMOS for Compact Designs

The objective was to design cameras that were as small as possible so that two of them could be used right next to each other. Additionally, they were to be equipped with a full frame shutter to get the disturbing oval distortions caused by a rolling shutter out of the picture. CMOS sensors designed for compact structures appeared to be an ideal solution, given that they offer high read-out rates and because they are relatively inexpensive considering their high resolution. However, those that come with the desired shutter, which can freeze an entire image frame upon an impulse, are few and far between. Nonetheless, Eltec found one equipped with a sensor that directly delivers the digital data from the sensor, which made the implementation in a serial LVDS format for the transfers very easy to achieve. The selection of optimum transmission frequencies allows the use of budget priced patch cables for Gigabit Ethernet applications. The lengths of these cables can range from 20 cm to 15 m, which makes it easy to create setups that extend from compact to highly distributed. Eltec uses CMOS sensors with wide VGA resolution and a frame rate of 50 Hz (non-interlaced), which are equipped with a freeze frame shutter to ensure the true-to-reality recording of moving objects and make it possible to achieve LVDS transmissions at rates of up to 700 Mbps per channel. Nonetheless, CCD sensor solutions that make it possible to meet special requirements, such as redu-



Innovative camera concept with small offset camera heads

ced noise levels, are also available. The camera heads, which include the sensors, are small and lightweight.

Complete PC Functionality on a Card

The next engineering challenge was boosting the computing power of the CPU. Even at a 400 MHz cycle, power conservation wizards can be found. The company chose an ETX module that offers all of the functions of a PC on a card. It even has a graphics outlet so that a full operating system with a graphic interface can actually be used. The key specifications of the ETX CPU module comprise the following: one Geode LX-800 CPU boasting 500 MHz, one graphics controller in the chip set with up to 1280 x 1024 (85 Hz), one PCI interface with 32 bits/33 MHz and a 512 MB SO-DIMM memory on-board.

ETX and COM modules sit on carrier cards, which also provide project-specific I/Os. For the image acquisition process, this particular application called for an interface between the digital camera interface and the hard disk, which is filled by the DMA. An FPGA handles this specific task with power and flexibility. All control outputs utilize the Profibus, i.e. a field bus. Pre-fabricated complete interfaces, which frequently master critical real-time communications and which can be optimally triggered via dual port RAMs, are available on the market. The 160 mm x 100 mm format media card contains what is needed for the power supply, which operates at a voltage of only 24 V/20VA (12 typ.), as well as video inputs via RJ45 plugs, the DMA controller as well as the Profibus interface DP Slave.

The next item on the list was the selection of the software. The decision was made for Linux, which offers a complete development environment (Eclipse). For Linux, the field bus was adapted and a port for the image acquisition process was set up. Debian Linux was used, featuring core 2.6.24, which boots from the on-board flash disk and requires 1 GB of memory space.

To turn all of these components into an intelligent camera, they are fitted into an add-on weather guard housing. By that time, they are already encased by an EMV housing. The distributed utilization of the equipment was tested as well: the LVDS distance between camera and computer core can be expanded to up to 70 m.

A Diverse Range of Applications

Which applications can this innovative camera solution handle? In the concrete case in question, the objective was to create a solution for the recognition of containers in real-time. In the case of video recordings, real-time translates into 40 millisecond delays. Nonetheless, this is obviously just one of many possible implementations. However, the type of camera to be used may or will have to be changed depending on the application: The portfolio also includes CCD sensors for low noise recordings as well as CMOS sensors that boast extremely high resolution levels of up to 5 megapixels and rapid read-outs. The ETX and COM modules can also be adapted to meet the requirements of their pertinent applications, which may include upgrades to up to dual core CPUs with cycles of more than 2 GHz. The media board, which has a project specific structure anyhow, can obviously also be equipped with different field bus interfaces. The number and speed of the camera interfaces can also be modified. The possibilities, depending on specific projects, for which Eltec offers tailor made solutions, are endless.

Compact camera heads with CMOS-/CCD sensors

Cost-effective cabling with Ethernet patch cables

The innovative camera concept has a modular structure and addresses many diverse applications ranging from the production of electronics to automation and process control to transportation and logistics to security applications. The scalable solution can process up to 32 cameras on a single base unit. Thanks to the industrial duty budget-priced cabling solution, which works with Ethernet patch cables, users can seize the benefits of the entire scope of modern embedded technology applications. This innovative camera solution encompasses the following basic components:

- Camera heads with CCD and CMOS sensors,
- COM express and ETX-CPU modules,
- Frame grabbers with up to 32 camera connections,
- Computer interfaces with FPGA technology,
- Application-based I/Os,
- Linux software.

The functions that control the camera work independently from the pixel interface via interference protected RS 485 connections. The pixel interface is fully FPGA implemented in the cameras and in the frame grabbers. As a result, multiple cables can be operated in parallel. The error detection solution, which is implemented in the FPGAs, makes it easy to monitor the consistency of the data.

The transmission format was chosen with the objective of attaining maximum transfer rates while simultaneously reducing the cabling costs. The highly cost effective category CAT 5e patch cables, which are used in large numbers in Gigabit Ethernet applications, were determined to be the logical solution. The image data is transferred via an LVDS interface.

High-bandwidth Server Technology

It goes without saying that the computer has to be able to process the data that is transferred from the cameras. In such applications, a standard PC, which has three expansion slots, quickly reaches its limitations. The server technology utilized by Eltec and its extreme bandwidth offers substantial advantages when used in conjunction with applications that involve cameras with high image rates or multiple cameras. The solution allows the connection of up to 20 cameras that all transmit data simultaneously to one single system. The company also offers network interfaces for direct connection to GigE.

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From Analog to Digital

Digital Technology – the Future of Machine Vision

Analog cameras dominated the early years of machine vision systems, offering adequate performance, a simple interface, and a moderate price. Technology advances, however, are now tipping the scales in favor of digital cameras for most new and many legacy applications. Dropping prices, standardized interfaces, and opportunities for customized preprocessing are making the analog to digital transition painless and profitable.

In the earliest years of machine vision systems, the only video cameras available were those developed for television. These early cameras produced an analog signal at a fixed 30 frames per second with limited resolution. They were neither intended for direct connection to a computer nor for use in a control loop of any kind. To utilize them, machine vision systems needed to incorporate an integrated digitizer and frame grabber to convert and store the video information for processing.

The structure of an image processing system that uses an analog camera thus has three elements, as shown in figure 1. The camera provides a simple analog signal, typically conforming to the RS-170 standard, carried on a conventional coaxial cable to the frame grabber. The frame grabber uses an internal digitizer to convert the analog signal to pixels and stores the data in memory. An image processing element, typically a PC, takes data from the frame grabber for processing and display. Because the frame grabber and the image processor are independent system elements, their programming is not automatically coordinated.

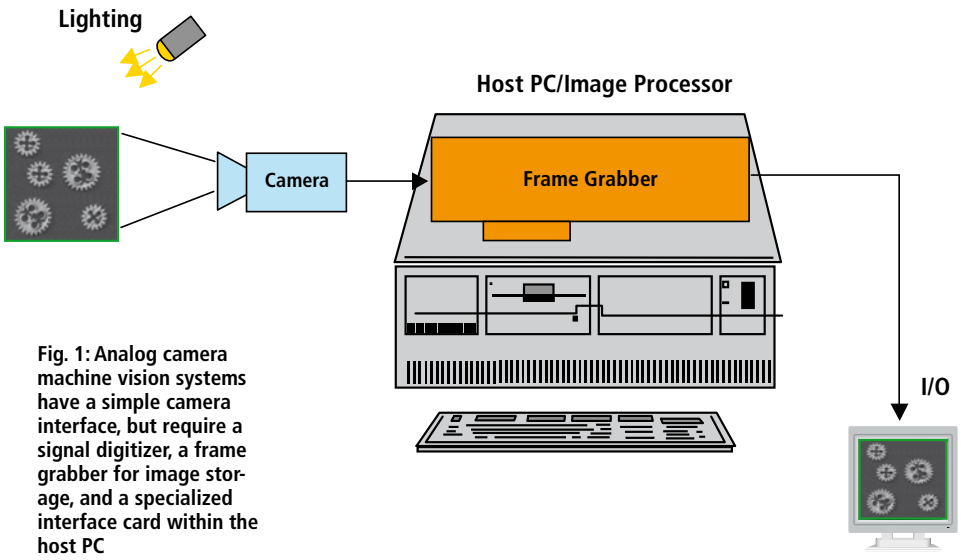
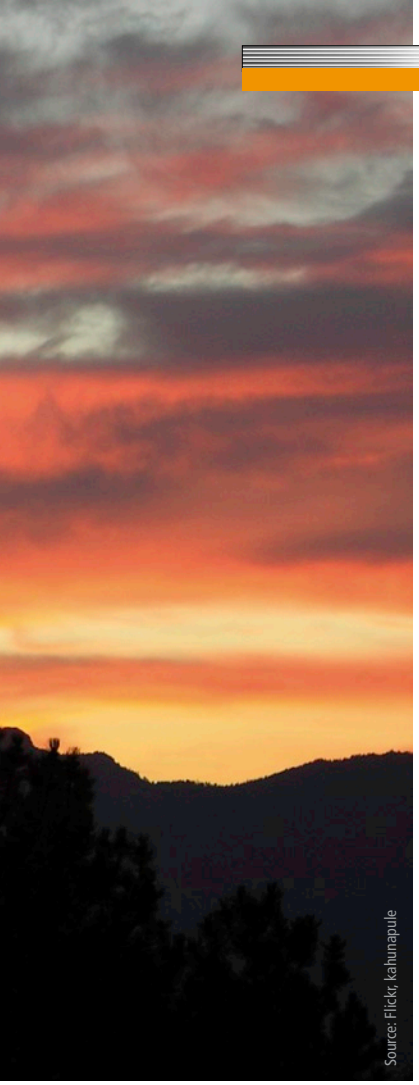


Fig. 1: Analog camera machine vision systems have a simple camera interface, but require a signal digitizer, a frame grabber for image storage, and a specialized interface card within the host PC

Using an external digitizer with an analog camera creates some side effects that complicate image processing. One is ambiguity in the relationship between the physical location that a digital sample represents and the corresponding pixel's location in the digital image. The digitizer's sample clock and the camera's line signal sweep must be coordinated and repeatable for the resulting pixels to produce a spatially correct image. Synchronization errors, as well as timing jitter in the sampling clock, will result in image pixels that are offset from their true location (see fig. 2).

Another side effect of external digitization is that the horizontal and vertical resolution of the image can differ. The analog camera's line rate determines the image's vertical resolution and the digitizer's sample rate determines the horizontal resolution. Without careful matching of the digitizer to the line rate the image pixels will not represent the square



area samples that image processing algorithms assume. Matching to achieve square pixels, however, locks the system data rate to the camera's line resolution.

Digital cameras behave quite differently. Each light-gathering region on a digital sensor receives independent digitization that does not depend on clock timing, so synchronization is not needed and timing jitter does not introduce spatial distortion. This timing independence means that sensor physical design alone determines both horizontal and vertical resolution, so image pixels are inherently square. Further, the clocking speed for digital camera image transfers becomes, essentially, independent of the image resolution. The only clocking requirement is that the system's pixel clocking rate must be fast enough to transfer the entire image within the frame time. Even that is not a hard and fast rule. Digital cameras can be configured to transfer out only an area of interest within the image, reducing the requirements on the pixel clock.

Digital Interfaces Simplify

Because the data coming from the camera is digital, the interface to the rest of the machine vision system is somewhat more complex than for analog cameras. Early digital camera designs used proprietary, high-speed interfaces with low-voltage differential signaling (LVDS). This required large, bulky, and expensive cables that could only run for a limited distance before connecting to the frame grabber or processor. Further,

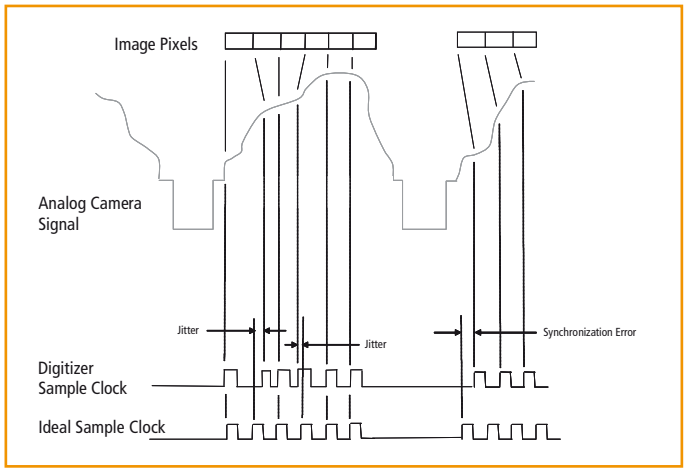


Fig. 2: Because analog camera vision systems use an external digitizer, the correspondence between pixels and physical locations depends on synchronized and consistent timing in order to avoid spatial distortion in the image

Fig. 3: This sawmill uses machine vision to determine where a rough-cut board will be divided into standard lengths in order to eliminate defects while maximizing the length of the resulting lumber (Image courtesy of Comact)

because the camera interfaces were proprietary, system developers needed to ensure that the frame grabber or processor interface they used would match the camera's interface. In practice, this often meant obtaining both elements from the same manufacturer to ensure compatibility.

The situation has been changing over the last decade, however. Today's digital cameras now offer improved interfaces to simplify system assembly. They also offer improved image sensors, capable of much higher speeds and resolutions than analog cameras. The digital nature of the sensors has also opened an opportunity for cameras to incorporate functions beyond image capture, increasing system design flexibility.

One of the first changes seen in digital cameras was the development of standard system interfaces. The proprietary digital interfaces limited developers to specific camera/system combinations. The rise of standard interfaces freed developers to mix and match components from different vendors as needed to meet their application requirements

CameraLink was one of the first standard digital camera interfaces to arise. Developed in 2000, CameraLink standardized connector pinout and signal electrical characteristics for the interface cable. The cable was still bulky and expensive, however, comprising 26 strands that carry parallel digital bit and control signals. The cable was also still relatively short with a 10 m length limit as compared to the 100 m length allowable under analog's RS-170.

More recently, high-speed serial digital camera interfaces have arisen, including FireWire and Gigabit Ethernet (GigE). The move to a high-speed serial interface brought several advantages that addressed CameraLink's limitations. One advantage was a reduction in cable complexity and cost. A 10 m CameraLink cable has a large, multi-pin connector and costs about $250. A GigE cable, on the other hand, is category 5 coax and costs around $15.

Of the two serial interfaces, GigE has arisen as the most advantageous. The electronics industry's extensive use of Ethernet ensures that expertise in and support for the GigE interface in machine vision systems is widely available, compared to the more limited availability of FireWire expertise and support. One indicator of the difference in support levels is that FireWire remains a specialty interface while Ethernet is now a standard interface on almost all new PCs.

A second advantage of GigE over FireWire is the cable length supported. FireWire remains limited to a 10 m length, but GigE is virtually unlimited because it is the interface standard for networking. A camera with a GigE interface can be part of a machine vision system located on the far side of the world. The use of GigE also provides electrical isolation between camera and system and benefits from continuing innovation and technology developments that arise in the networking industry.

The development of standardized camera hardware interfaces has recently led to standardization in the software and control interface, as well. Within the last three years considerable progress has been made toward creating a common set of command options for digital cameras so that application programs can become independent of the camera choice. Applications simply make standard calls to drivers that handle any data format or other hardware-specific differences.

Camera Capabilities Expand

In addition to improving system interfaces, modern digital cameras have expanded the capabilities of their image sensors. The best analog cameras today have a resolution limit of about 1M pixel with 30 to 60 frames per second (fps) image capture speed, for a data rate of about 40 MHz. Digital cameras, on the other hand, can easily achieve 100 to 200 fps with digitization speeds up to 160 MHz and resolutions that can go beyond 10M pixel.

Digital cameras also provide a much simpler and cheaper approach to color than analog cameras. In digital cameras the three color signals (red-green-blue) are all automatically synchronized and use the same serial interface as monochrome cameras. Analog cameras, on the other hand, must provide three independent signals and synchronization of the digitization process requires careful handling in the frame grabber. A composite color video signal that needs only a single cable is possible, but at the cost of reduced resolution and color fidelity.

One of the latest innovations to arise in digital cameras for machine vision is the availability of image preprocessing in the camera. A pre-processed video signal still has the data structure of an image, but has undergone some changes in the data content. The range of possibilities for the kind of changes a camera can introduce is wide open. For instance, a digital camera can readily put a time stamp on each image frame by selectively replacing data with white or black pixels to form numeric characters in the displayed image. Other possibilities include flipping the image vertically or horizontally, passing data through a threshold filter, or adjusting gain to increase contrasts. Many of these tasks are difficult or impossible to implement in an analog format.

To read the full article, please visit the INSPECT portal online at www.inspect-online.com\white-paper

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Netbook Vision

Alternative Configurations of Vision Systems Featuring USB Technology

The USB interface was developed years ago by Intel with the goal to replace many of the PC interfaces used up until then (RS232, parallel port, PS2) with a standardized modern device. In spite of the fact that USB was hopelessly outgunned by FireWire, at least in the beginning, it could still prevail in the PC domain through the sheer market dominance of Intel. Point Grey Research, supplier of advanced imaging products, employs the USB 2.0 interface for the new models of the Firefly MV digital camera family.

The Firefly MV line offers a total of 10 different combinations of form factor and interface that are designed to address a wide variety of applications in industrial and non-industrial imaging, such as object and gesture tracking, optical character recognition (OCR), augmented reality, and multitouch interface technology. The new USB 2.0 models use the same CMOS sensor as the existing IEEE 1394 (FireWire) versions, support 480 Mb/s data transfer rates, and can be connected to any computer system with hi-speed USB ports.

"One of our original goals when we first introduced the Firefly MV in 2006 was to offer a low-cost, easy-to-use OEM camera that could be used in both machine and computer vision applications," says Vladimir Tucakov, Director of Sales and Marketing at Point Grey Research. "Giving users the choice of an IEEE 1394 (FireWire) or USB 2.0 interface fits perfectly with that goal, and also allows us to address new OEM opportunities. The FireWire models, for example, are excellent for applications that require 400 Mb/s data rates and multiple synchronized cameras running on a single PC. The USB 2.0 models, on the other hand, are intended for single camera systems where the customer wants to simply plug the camera into a computer without connecting a separate FireWire interface card."

"The other key advantage of the Firefly MV has always been its unbeatable value," adds Tucakov. "With a price tag of just US$ 199, it's possible to construct a complete vision system – PC, operating system, software, cables, and optics – for less than US$ 600. We actually demonstrated a similar system, which included an ASUS Eee PC with Intel Atom processor, Linux operating system, and OpenCV open-source vision software library, at Vision 2008 in Stuttgart."

The Firefly MV camera uses a 1/3˝ wide-VGA CMOS sensor with global shutter to deliver high quality 752(W) x 480(H) monochrome or raw Bayer color images at 60 FPS, and offers a 2x2 binning mode for frame rates up to 135 FPS. Configuration options include a choice of IEEE 1394 or hi-speed USB digital interface, board-level or housed form factor, and M12 microlens or C/CS lens mount. The USB 2.0 models are equipped with a CS-mount lens holder with removable glass/IR filter system and housed in a small and lightweight 44 x 24 x 34 mm plastic case. A board-level option, which is the same size as its FireWire counterpart at just 40 x 25 mm, is available for qualified OEM's. A 7-pin general purpose I/O connector can be used to synchronize the camera to external devices, such as an external trigger or light source, and its 5-pin Mini-B USB 2.0 connector enables the USB 2.0 cable to transfer both data and power.

Like all Point Grey cameras, the Firefly MV complies with the IIDC v1.31 specification. Existing Point Grey camera users will benefit from the seamless software integration that is available using the FlyCapture Software Development Kit (SDK). The FlyCapture SDK is compatible with both FireWire and USB 2.0 cameras using the same API, and includes support for ActiveX, TWAIN and DirectShow.

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Best of Both Worlds?

FireWire and GigE Racing for the Pole Position

The GigE Vision standard is rapidly gaining market share over other machine vision camera interfaces. Does that mean that FireWire, the currently leading digital interface, is bound to disappear? If not, which interface is best for which application?

Since the introduction of the GigE Vision standard, Gigabit Ethernet is rapidly gaining market share against other camera interfaces and there seems to be a consensus on the fact that it will play an important role in the future. However, sales figures of digital cameras for machine vision applications still put FireWire as the leading digital interface. The acquisition of Prosilica by Allied Vision Technlogies demonstrates a clear commitment to GigE from the worldwide leading manufacturer of FireWire cameras. Does that mean that Gigabit Ethernet will replace FireWire and maybe other interfaces as the leading standard of the industry? Or will both technologies complement each other so that they will still coexist in the market?

Cost-effective Standards

Both interfaces have one thing in common: FireWire and GigE use highly standardized hardware and data transmission protocols, offering true plug-and-play compatibility of the components and easy integration in a system. The IIDC/DCAM standard guarantees easy integration of compatible IEEE 1394 devices from various vendors while the GigE Vision and Gen<i>cam standards ensure the compatibility of Gigabit Ethernet components. This saves developers time and money in the design of their imaging systems.

This exhibition demo illustrates the principle of a daisy chain network with direct FireWire connection from camera to camera

The relatively low cost of the hardware components and accessories makes both interfaces a good choice for cost-sensitive applications. FireWire being originally a consumer electronics interface, it is widely available in the market and many PCs have an IEEE 1394 port on board. Plugs, cables and other accessories are affordable and easy to purchase from any local retailer. This is even more true with GigE Vision, as this interface uses Ethernet connectivity (Cat5), which has been used as the most common standard in IT networks for years. Mass produced cables and components are extremely easy to find and even

Smallest GigE Vision camera available: Prosilica GC

counts, an AVT Guppy, one of the smallest FireWire cameras available, takes even less space (48.2 x 30 x 30 mm).

An often considered aspect in the choice of the interface is the possible transmission range between the system PC and the camera. In that respect GigE Vision clearly is the interface of choice as it allows for up to 100 m cable length, or up to tens of kilometres using low-cost fiber optic media converters. However, the possibilities of FireWire in terms of cable length are often underestimated. It is true that the IEEE 1394 standard only guarantees data transmission over 4.5 m, but this by far does not mean that longer distances cannot be bridged in practice. For example, Allied Vision Technologies has intensively investigated the matter and, based on extensive tests, commits to cable length of up to 10 m with IEEE 1394b and 17 m with IEEE 1394a interfaces. Should longer distances between PC and camera with FireWire interface be required, repeaters offer a practicable solution. It is even possible to bridge very long distances using optical fiber (GOF). With its Pike and Stingray models, Allied Vision Technologies is the only vendor offering FireWire cameras with an optional GOF port, which


Source: flickr/David Sherret

cheaper than FireWire accessories.

The prices for the cameras themselves are still about 10 % higher for GigE than for FireWire products. It is therefore recommended to consider the global cost of the system, including all peripherals and accessories such as cables, repeaters, switches or PC-cards. Depending on the architecture and the complexity of the system, either FireWire or GigE Vision may turn out to be the more economic solution.

When Size Matters: Form Factor and Cable Length

The physical size of the camera can be very important for specific applications. Because Gigabit Ethernet components are less miniaturized than FireWire, GigE cameras still suffer from a slightly larger form factor than their FireWire competitors. The smallest GigE Vision camera in the market is the Prosilica GC Series. This camera has an extremely compact form factor (33 x 46 x 51 mm). However, when each millimetre

makes it possible to transmit image data over up to 500 m.

Bandwidth and Reliability

With up to 125 MB/s, GigE Vision clearly offers the highest bandwidth. Among GigE Vision camera vendors, Prosilica has proven to be extremely efficient in making the most out of this bandwidth running sustained data rates of 124 MB/s. In FireWire, Allied Vision Technologies achieves higher bitrates than specified by the standard with up to 84 MB/s with IEEE 1394b.

Both interfaces being digital, they offer a high reliability of the data transmission. Lost or corrupted data is nearly impossible. The Gigabit Ethernet standard guarantees for additional safety since data packets can be resent if necessary, which is not possible with FireWire. However, the event that streaming packets become lost or corrupt during transmission is extremely unlikely in a properly designed system.

Power Supply and Heating

The FireWire and GigE Vision interfaces are quite different as far as the power supply of the devices is concerned. FireWire cameras are usually powered directly over the FireWire port, which highly contributes to the plug-and-play ease of installation: just plug in the cable and the camera runs! Power over Ethernet has now become available too, but it is not a standard feature of the interface and is therefore not very easy to implement yet. Most GigE cameras do not support power over Ethernet and even if it is the case, it is very likely that the Ethernet port of the PC will not, so additional accessories such as a new Ethernet card or a powered switch have to be purchased.

Gigabit Ethernet cameras tend to consume more power than FireWire cameras. This may turn out to be a disadvantage in mobile applications powered with batteries. Related to this higher energy consumption is also a higher heating of the camera which might be problematic in some specific applications. However, some GigE Vision cameras perform very well compared to FireWire. For example, the power consumption of Prosilica's GC750 is 2.5 Watt, which is as low as that of comparable competitive FireWire cameras.

Multi-Camera Operation: Network versus Bus

Industrial image processing systems often rely on several networked cameras.

The capabilities of an interface in the area of multi-camera operation are therefore often crucial for the choice of the most appropriate one.

IEEE 1394 and GigE Vision have two different philosophies: FireWire is a bus standard, while GigE Vision is based on an Ethernet network. According to the strict communication protocol of the FireWire standard, devices on the bus can only transmit data on the bus after each other within clearly allocated timeslots. As a result, system developers can very precisely calculate and plan which data from which camera is to be transmitted when to the processing computer. Using a Resource Manager, it is possible to make sure that the bus cannot be saturated with image data sent by several cameras at a time.

In a Gigabit Ethernet network, all devices can send data at the same time, which means that the limits of the bandwidth may be reached. A bottleneck risk exists specifically when a switch connects several cameras to the network. If the capacity of the switch is saturated by a too high amount of data, the data will not necessarily be lost, but delivery delays can occur and, more importantly, it is not predictable which data will be delivered when to the PC. With their unique StreamBytesPerSecond function, Prosilica Gigabit Ethernet cameras feature a sophisticated bandwidth management function which can be considered best in class in the GigE Vision camera market. It ensures that image data is reliably and predictably delivered in multi-camera operation.

However, as a standard, FireWire still offers the more structured communications protocol for multi-camera applications requiring precise prediction of data input into the processing computer.

Another unique benefit of the FireWire interface is the possibility of "daisy-chain" connectivity. Cameras equipped with two IEEE 1394 ports such as AVT's Pike or Stingray series can be connected directly with each other like pearls on a necklace. That way, it is possible to easily build a multi-camera bus with only one FireWire connection on the PC side and no hub or accessories others than standard cables.

The GigE Vision standard does not limit the number of cameras that can be operated in one network. There is a limit of up to 63 cameras on a FireWire bus but this limit is far higher than the vast majority of machine vision applications require. Even if a system required more, it only takes a standard four-port PCI card to operate up to 252 cameras with one PC. In fact, both for FireWire and GigE Vision, the total amount of cameras that can be operated simultaneously is rather limited by the available bandwidth than by the standard itself.

Reviewing these different criteria, it becomes obvious that the choice of the better interface really depends on the requirements of the specific application: for some systems the form factor is key, for others the cable length or power supply. Users of complex multi-camera systems will probably value the advantages of the FireWire bus standard as they did before, while GigE Vision is the interface of choice for applications requiring long distances between camera and processing computer such as traffic monitoring. Both interfaces complement each other and together, they will surely dominate the machine vision market of the future.

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New USB Cameras and CameraLink Cameras

At Vision 2008 Videor presented product innovations from Fujinon and Tamron as well as the extended USB camera series from Sentech: In the new T Series all cameras can be triggered by software command, and hardware-triggered models are in the pipeline. The cameras are available in VGA, XGA, SXGA and UXGA, with a choice of colour or black/white, as a board camera or in a housing. Their resolution ranges up to 1,600 x 1,200 pixels, the 2-megapixel versions come with the latest 1/1.8" CCD sensors from Sony and deliver a frame rate of 15 frames per second at full resolution. The shipping package includes DirectX drivers for Windows XP and Vista, as well as a viewing and configuration package. Additionally, a complete SDK is available free of charge as well as drivers for certain Linux distributions.

Videor E. Hartig GmbH
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800 Mb/s FireWire-Over-Cat5e Repeater

Point Grey Research announced at the Vision 2008 the addition of the LDR (Long Distance Repeater) to its FirePro family of professional IEEE 1394b components. The FirePro LDR is a compact and cost effective solution for applications that require multiple IEEE 1394 devices to be extended beyond the standard 4.5 m cable length. Using a Gigabit Ethernet (GigE) physical layer to transport FireWire data using GigE signalling, the FirePro LDR can transmit and receive IEEE 1394b 800 Mb/s data in real-time over 100 m of standard Category 5e (Cat5e) cable. This allows users to construct a dependable, high-speed FireWire-based network of multiple cameras that is physically separated by up to 100 m from the host system.

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High Resolution FCB

Sony's Image Sensing Solutions division has announced the launch of its second high definition FCB camera module. The new FCB-H11 builds on the success of 2007's FCB-H10, bringing several new features to the renowned performance. This includes an ability to work in low light conditions through the addition of an auto ICR, which enables a day/night function and operation at an industry leading 1lx for true high definition resolution. This new functionality will give Sony access to a broader application base. In addition to videoconferencing and broadcast applications, the new camera block is ideally suited to potentially low light situations that require high resolution images, in particular, intelligent CCTV/security, and environments that require high-quality remote monitoring such as surgery lamps, crane control, remote vehicle and motor sport.

Sony
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Super Wide Angle Lens

Carl Zeiss has now introduced the Distagon T* 3.5/18 ZF for industrial applications and technical automation – a compact wide angle system covering an extremely wide image angle. Many industrial imaging applications demand more than excellent imaging performance. Only an extreme image angle can ensure that large objects are captured reliably and completely in a small space. With the new Distagon T* 3.5/18 ZF industrial robots for quality assurance tasks achieve an impressive diagonal image angle of up to 99°. This means maximum acquisition of ambient and object information, even at short distances, making the lens ideal for near-range photogrammetry and optical measurements of components, e.g. in the automotive industry. The Distagon T* 3.5/18 ZF offers low-distortion, sharp images from infinity up to the near range – even in difficult light conditions.

Carl Zeiss AG
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16 Megapixel Camera

JAI added a new 16-megapixel high performance CCD camera to the company's multi-tiered C3 Camera Suite. This new progressive scan camera incorporates the Kodak KAI-16000 dual-tap sensor to deliver full 4,872 x 3,248 pixel resolution at three frames per second. The new high resolution camera is available in two models: AM-1600CL (monochrome) and AB-1600CL (raw Bayer color). Both models feature Camera Link interfaces offering user-selectable 8-bit, 10-bit, or 12-bit output. As a member of the Advanced tier of the C3 Camera Suite, JAI has designed the camera to be both high performing and highly reliable. A series of pre-processing functions are built into the camera to achieve high image quality while offloading these tasks from the user's host PC.

JAI A/S
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Orchestration of Machine Vision

LMI Technologies introduced maestro at Vision 2008 in Stuttgart. The new product allows engineers to rapidly design, install, and start-up any machine vision solution while reducing time, materials, and costs using only two universal maestro modules for all installations. maestro is comprised of two modules. The P800 module is the master controller that interfaces with the encoders and the I/O, but also delivers microsecond synchronization, power, and safety on CAT5E cables for up to 8 or more cameras and light sources, all from a single power supply. All timing, triggering, synchronization, sorting, and reject activations are completed by the maestro P800 module. As a result, all devices are slaves to the P800 controller, including the host computer that performs the image processing.

LMI Technologies Inc.
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Series of New Products

Framos was once again represented as an exhibitor at the Vision and the Electronica trade show in 2008. The following highlights were introduced: Sony CMOS sensor. It features very high light sensitivity which was only known in industrial CCD sensors to date. As a result, the sensor is suitable for various areas of application such as security and surveillance equipment. In addition, Framos introduced an HDTV sensor from Thomson – also based on CMOS technology – which is currently unique in the market with 2 megapixel resolution and an image rate of up to 90 images per second. One major highlight in the camera area is the 12 megapixel Teli camera, with a 4x greater frame rate than comparable products currently on the market. Users were extremely interested in the camera.

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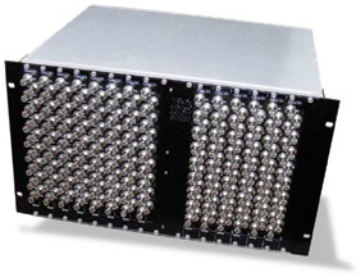
Pylon Driver SDK for Free

Basler Vision Technologies is now offering the full pylon Software Development Kit (SDK) for free. It can be downloaded from the Basler Website. "Free download via the web will replace all distribution methods we used in the past," explains Werner Borchert, Product Manager at Basler Components. "We have constantly increased the speed and efficiency of our development cycle without losing any of pylon's well-known high quality." The Driver operates with all Basler GigE Vision and IEEE 1394 area scan and line scan cameras. The driver's full compatibility with the GenICam standard provides the benefit of a unified C++ camera API for both area and line scan cameras. Due to a generic design approach, the driver makes new camera features such as the I/O Debouncer or Auto-Exposure immediately accessible without the need for a software update.

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

Digital Video Surveillance



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 feature 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
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Cell/B.E.-Processors for Machine Vision

The Cell/B.E. processor (also Cell processor), which drives the Roadrunner in Los Alamos with over 1 Petaflop/s to be the fastest computer of the world, features high processing power referring to algorithms in visualization and image processing. With optimized image acquisition components, Matrix Vision makes it possible to use this power for industrial image processing applications. The power of the nine cores of one Cell/B.E. processor, each with 3.2 GHz, corresponds to the power of up to 12 conventional PCs. Cell Blades contain two Cell/B.E. processors and according to this they offer highest power in little space. For industrial applications, normally PCIe frame grabbers are used, which are placed in a special enclosure or installed next to the Cell Blade into a PCIe adapter.

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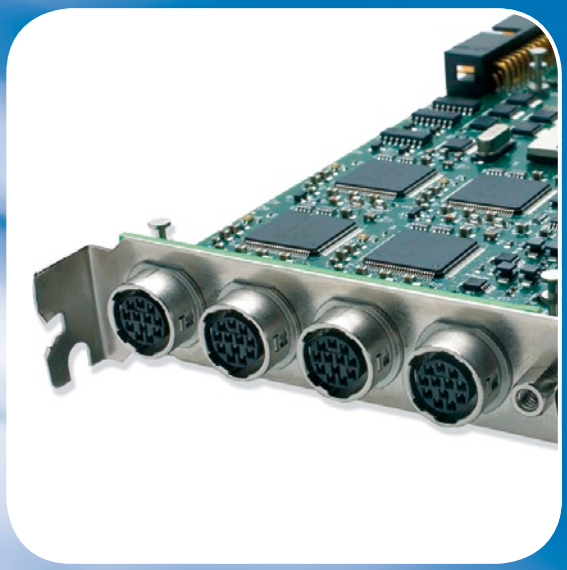
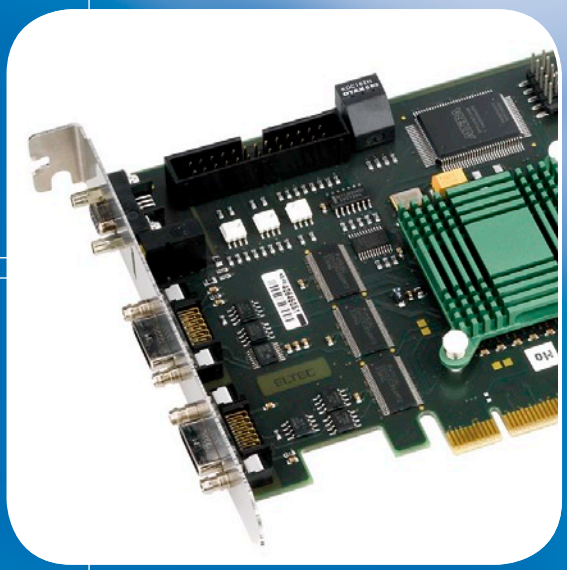
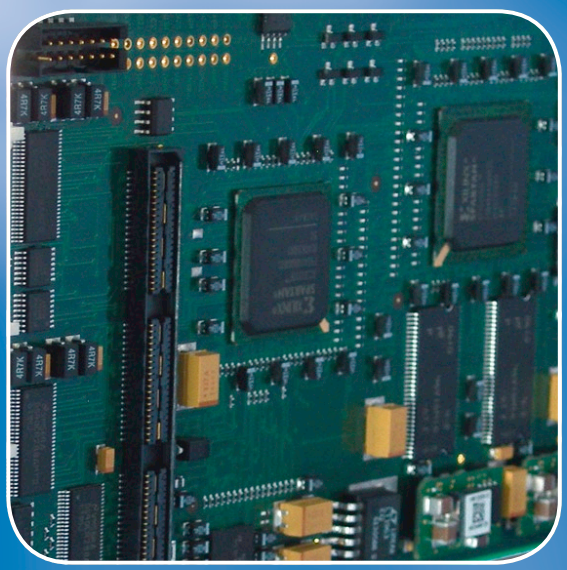
INSPECT

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.
In this issue you'll find what experts said when asked in which applications the frame grabber will stay indispensable.

Glass Tube Inspection

A Customer-specific System for Manifold Use

The lighting industry is a major user of glass tubes. Fluorescent, halogen or Xenon lamps – they are all produced using glass tubes. The glass composition and the production method for the tube depend on the application. The techniques used to cut the glass tube for further processing are different, too.

The details of the glass tube production steps are the specific know-how of the manufacturers. The common thing about all glass tubes is that their quality meets the specification in the end. The requirements are clear in this point:

- The glass must not have any air or foreign particle inclusions.
- Neither dust nor dirt from the cutting is allowed on the glass surface.
- Scratches on the glass surface are not accepted.
- The tube edges need to be free of damages. Chipped off glass or even cracks are not tolerated.

FiberVision has built an inspection system which checks all these quality features of glass tubes.

Set-up of the Glass Tube Inspection System

The whole lateral surface as well as both product edges have to be inspected according to the quality requirements of the glass tubes. The product has to be held in some way for inspection. Thus, it is evident that one camera image cannot be sufficient to check the entire tube. The FiberVision glass tube inspection system uses two cameras. They inspect the two product sides one after the other. Thereby, the product is held on the side not inspected in each case. The second side of a certain product is inspected when the camera of the first side has already inspected some later products. This is due to the construction of the mechanical feeding. The FiberVision inspection system saves all images and results of the first side until the result of the second side is available, too. The PLC will receive just the final sorting result for a certain product. The PLC interface is Profibus.

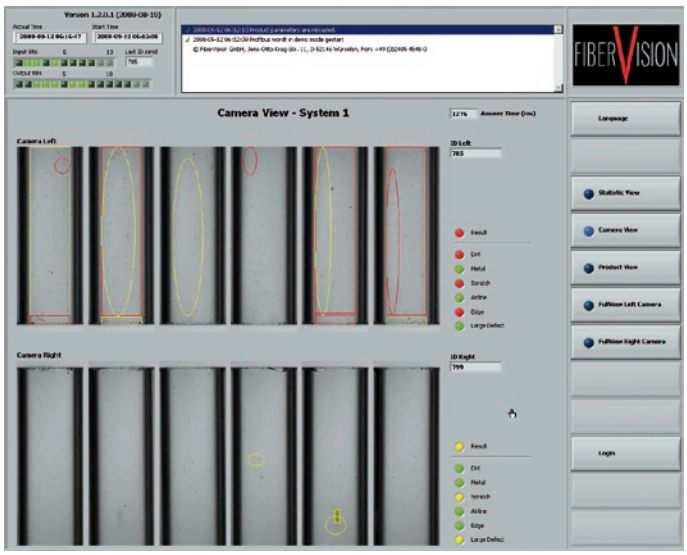
Even if two cameras share the inspection task – just one image per camera is not sufficient anyway. Any failures in or on the glass are only well visible if the surface involved is facing the camera. About 60 degrees of a glass tube can be inspected with one camera view. Thus, six images have to be taken to inspect the complete surface. The product is rotated for 60 degrees between the different image takings.

The "normal" entocentric lenses known from photography capture the product edge with an elliptical shape. This shape is not useful for defect detection at the product head edges. Even the inspection of the lateral surface is limited since the defect search cannot be extended to the edges since the back side product edge is visible in the area of the front side lateral surface.

The product end placed close to the image limits appears as a straight line when using telecentric measurement lenses. These lenses produce images without perspective distortions. The detection and measurement of edge defects become possible with their help. The lateral surface is inspected right to the edges. Telecentric lenses have a fixed scale. The area seen in the camera image is specified by the lens chosen and cannot be changed. Thus, the size of the largest product to be inspected has to be specified very carefully in the design phase of an inspection system. It is impossible to increase the camera field of view just by in-

Comparison of entocentric (left) and telecentric (right) lenses: The product edge appears with elliptical distortions using entocentric lenses. Telecentric lenses show the edge as a straight line

View onto a testing facility with four cameras for the inspection of up to 3,600 products per hour



The user screen showing the current inspection results of the cameras

creasing the distance to the object a little bit whenever telecentric lenses are used.

The image brightness will decrease close to the lateral product sides even if telecentric measurement lenses are used. The brightness distribution depends on the optical properties of the glass itself. The FiberVision glass tube inspection system compensates this effect. The decision if something is darker than the defect-free glass is made depending on the local brightness distribution in the camera image. The brightness distribution of the transmission lighting placed behind the product is compensated by the inspection software, too. These software actions assure the detection of even the finest scratches on the glass.

Scope of Use

The FiberVision glass tube inspection system has been built for glass tubes with a certain length and diameter. The sensitivity of the inspection system for smallest defects in or on the glass has been adapted to the specific requirements of the customer.

The inspection system can be customized to other requirements by choosing other cameras and lenses. Even very long tubes can be inspected with the FiberVision approach if a suitable amount of cameras is used.

The typical time needed for one inspection is two seconds. This time requirement is mainly due to mechanical product handling. The 1,800 products per hour throughput is increased by installing several inspection systems in one testing unit.

The FiberVision glass tube inspection has been designed as a customer specific system. Thus, individual solutions concerning data exchange, integration into existing equipment or the planning of completely new testing facilities are part of the concept.

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A Funeral Parade for the Frame Grabber?

INSPECT Expert's Survey about the Future of a Component

GigE, FireWire, USB …. you can't help but hearing obituaries for the frame grabber from all directions. Has the concept of frame grabber outlived its usefulness? Is this component obsolete? We think: no. And this is why we asked the experts "In which machine vision applications will the frame grabber continue to be needed and why is that so?" Read on why from their point of view the frame grabber is not so easily passed by when demanding applications are concerned.

Dr. Reinhard Borst, Director New Technologies Eltec Elektronik

Eltec has been developing and manufacturing frame grabbers for many years already. When examining these closely, one can establish that a digital interface is usually a standard feature, whether with LVDS, camera link or fiber-optics, and that image preprocessing in FPGAs is frequently already on the card. Nevertheless, analog interfaces are used if necessary, whether to permit the use of a high-performance CCD camera from a specific manufacturer or a special camera, e.g. for infrared.

Interface cards for connecting cameras are also required with Gigabit Ethernet if maximum performance is to be achieved with an acceptable CPU load, i.e. with more complex applications.

The strengths of frame grabbers – or let's call them video interfaces – are to be found in applications with many cameras, high bandwidth and possibly with integral preprocessing. Technologies such as Ethernet and USB are not designed for this – special interfaces have always been required for such complex applications.

Michael Cohn, CEO Parameter

The frame grabber has previously primarily been used as analog to digital converter in a wide variety of applications. With today's digital camera inter-

faces some of the more straight forward features in the frame grabber have moved into the camera. However, in the semi-conductor industry or other high-speed applications like print control, web inspection for paper, wood, steel or textile one often uses mixed camera types or high-speed cameras such as line-scan or TDI-cameras. To solve these applications you require absolute control of timing such as line synchronization and also management of the image data. This can still only be managed with a dedicated frame grabber.

In high-speed color analysis like food or fruit inspection the Bayer to RGB conversion is also preferably done in a frame grabber. Some cameras can do preprocessing in their FPGA, but typically speed decreases due to the increased band-width requirement of the RGB-format. In other demanding applications like military or medical applications, the required data reduction or image enhancement is best handled by dedicated hardware on the frame grabber.

The need to precisely control multiple cameras, dataflow and preprocessing will remain and also grow in applications using cameras with the new digital camera interfaces.

Dwayne Crawford, Product Manager Matrox Imaging

Despite the promotional campaigns for new digital interfaces, analog cameras still have a place in the vision market. The AIA's studies continue to show that camera manufactures are selling analog units, and they're selling a lot of them. Many OEMs continue to use these older technologies simply because they work well, are well understood and are still very cost effective.

In the future, complementary technologies will evolve, and they will bring with it larger, multi-core CPUs, higher bandwidth memories and interconnects. More demanding imaging applications will follow along. Once cameras with higher data rates and/or 3D and multi-spectral images become commonplace, interfaces and processors will be pushed to their limits. Frame grabbers will continue to be the vehicle to offload and allow these systems to handle the ever-increasing data rates and complex processing requirements.

The frame grabber might struggle in areas such as general manufacturing where the data rate is in the 10's of MB/s. Ethernet or FireWire bandwidths are sufficient for this market as long as jitter is not an issue and the standard, inexpensive host PC has enough computing power to handle the application.

Marc Damhaut, VP Product Management Euresys

Frame grabbers will typically continue to be needed in applications that require a high bandwidth. It can be because of the resolution or frame (or line) rate of the camera such as for PCB inspection or it can be due to the number of cameras involved such as for flat panel display inspections for example. In the context of machine vision, IEEE1394 and GigE Vision interfaces typically provide a bandwidth of less than 100 MB/s per port.

However, there are a lot of cameras available on the market that require a significantly higher bandwidth. These applications are currently only served by the CameraLink interface.

We also note that frame grabbers will remain a cost effective solution in even more applications. In the context of machine vision applications, using an IEEE1394 or GigE Vision camera may not require a „frame grabber" card per se, but still requires an interface card. „Traditional" frame grabbers, which are nothing else than interface cards dedicated to cameras, always provide valuable added functionality such as digital I/O lines that make them a cost effective solution. In the context of video surveillance applications, where dozens of cameras (16, 32, 64) have to be connected to a single PC, they are still the only affordable solution.

Uwe Furtner, General Manager Technics Matrix Vision

The charm of standard interfaces like USB and Gigabit Ethernet lies in the usage without additional interface boards. Given that FireWire could not become accepted as a standard interface in the PC world, this advantage does not apply here. The interfaces have in common that the used bus structure leads to latency, which excludes usability in many Machine Vision applications.

As soon as short reaction times or high data rates are requested, interfaces like CameraLink come into operation, which guarantee transfer rates up to 680 MB/s and an almost latency-free transfer via correspondent grabbers. Applications can be found in areas like quality control, textile industry, technology (e.g. inspection of LCD panels) or printing industry. Systems in the security area often consist of several hundreds of cameras. Here, grabber based solutions with analog cameras offer a considerable price advantage.

Matrix Vision will be represented with suitable solutions also in the future, which can be seen, for example, in the current frame grabber development for multicore processors.

Inder Kohli, Product Manager Dalsa

Diversity in machine vision applications is fueling the evolution and adaptation of frame grabbers despite the emergence of frame grabber-less image capture modalities such as GigE Vision, IEEE 1394a/b, USB2 etc.

The CameraLink, a dominant standard using frame grabbers, continue to evolve and progress. With CameraLink it is not only possible to go beyond 680MB/s on one hand but also provide one cable light-weight miniature cameras solution with PoCL/PoCL Lite on the other.

Due to their heavy dependence on the host CPU to reconstruct packets into usable images, standards such as 10GigE, when adopted for machine vision, will also require hardware assistance regardless of what this hardware is called. Increased data rates when combined with other operational requirements such as determinism, processing time, form factor, heat dissipation etc. benefit from frame grabber's versatility and adaptability.

Frame grabbers are tightly integrating external controls with image capture, re-translation and preprocessing tasks. For example, it is now possible for frame grabbers to convert Bayer images into RGB, L*a*b, YUV or HSI etc. while transferring the original image to the host memory in real-time and with zero host CPU utilization.

Michael Noffz, Marketing Manager Silicon Software

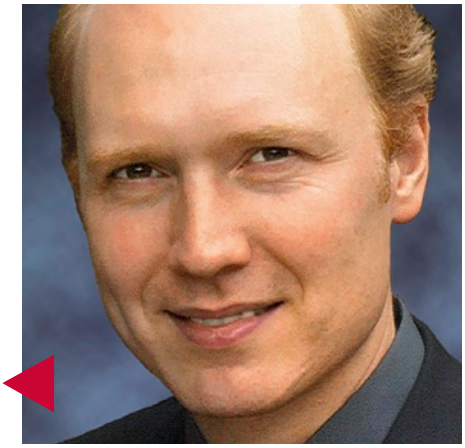
The concept of frame grabbers has been evolved despite of declining market figures for this branch. Especially the analog frame grabber section suffers from a downturn, followed by a trend to interface-less cameras. At the same time there is a move to advanced tasks and solutions for frame grabbers. Besides an image acquisition more and more complex image processing tasks are swapped onto frame grabbers. Even new interfaces like FireWire and GigE benefit from product developments in this field.

Application fields are divided in those with requirements of image acquisition and additionally of image processing. Applications, using line scan cameras or area scan cameras with high resolution or high speed requirements, still need a reliable and latency-free image acquisition in the future. Especially surface inspection in wood processing and refinement industry and print inspection will have a future need of frame grabbers with high requirements to the production and processing speed.

Because of missing alternatives for real-time processing on frame grabbers, the field of applications is heterogeneous. Examples are scanner and sorting systems with need of documentation or inspection systems for glass and glass substratum with automatic detection of surface defects.

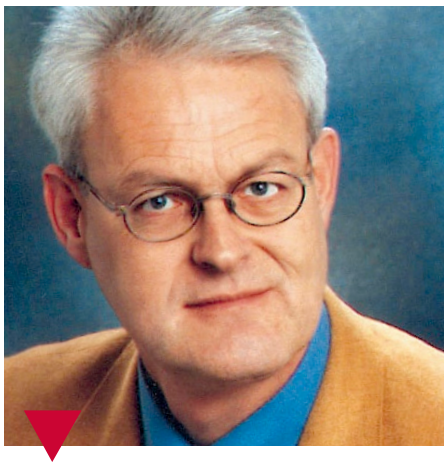
Helmuth Oberpaul, Managing Director Cosyco

In the area of High Speed Video Recording we are facing typical data rates from 100 MB/s up to 1 GB/s. These data rates are just not handled by mainstream camera solutions. Future tasks in research (rocket launch, film scanning and recording from vehicles like helicopter, airplane and cars) need cameras exceeding today's specs regarding sensitivity, resolution and frame rate. Some applications require recording from two or more cameras simultaneously. Only frame grabbers with special features will be able to



meet tomorrow's requirements. Today's hardware solutions include CameraLink frame grabbers with PCI-Express interface as well as SD-SDI/HD-SDI featuring on the camera side and PC-Card Express interface on the computer side (laptops) as well as frame grabbers with direct connections to disk arrays.

We did an exciting installation at the MPI in Garching. The system collects videos from a Photron camera with the resolution of 1,024x1,024 pixels at 1,000 fps at 10 bits gray level. Nonstop recording over 30 minutes. For this system we used two frame grabbers with Full CL interfaces each – and we see an increasing demand in performance in all areas of applications.



Alfons Rieder, Sales Manager SVS-Vistek

Appraising the importance of frame grabbers in today's market situation we have to differentiate: The low-end is either substituted by non-card based interfacing technologies like FireWire and GigE, or low cost products from Asia are applied; this means its importance is decreasing constantly. Whereas in applications of the high-end level frame grabbers are used frequently. However, these frame grabbers must meet with the client's requirements for a fast and easy to install data transfer between the camera and the PC.

Especially the demand for new developments like PoCL and PCIe compatible boards, and products with on-board processing units is very high. Applications with an extreme need of processing power in optical metrology or print inspection thus can be relieved from routine jobs like shading correction or Bayer Pattern interpolation. New applications in the fields of traffic monitoring or surveillance demand for use of frame grabbers with numerous analogue inputs and the possibility to receive compressed and uncompressed data streams simultaneously.

For the connection of industrial cameras with GigE interface more and more GigE frame grabber cards with several inputs and on-board processing power are available.

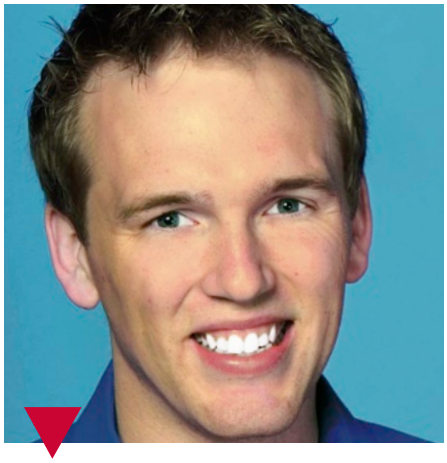
Georg Schelle, Sales/Product Manager Image Acquisition Stemmer Imaging

Frame grabbers are harder to justify in simple inspection tasks. Nevertheless, in the growing field of high-end and high-speed applications in the future it will be hard to solve these applications without a frame grabber. Line scan camera applications which need perfect timing and interaction of all components to work adequately are just one example of that.

In complex tasks such as solar panel inspection, print inspection or postal automation, a perfect synchronization between shaft encoder, lighting, cameras, frame grabber and software is not enough. Due to the high demands on the processing, certain tasks have to be solved separately.

The solution of choice here is to use the FPGA that is integrated on many frame grabbers for image pre-processing. Possible tasks are e.g. color space conversion, filtering, equalization and

compression. Based on that, a dramatically increased processing capacity can be combined with the CPU/GPU even for the most complex image processing tasks. Without a frame grabber, this will remain impossible for the foreseeable future.



Matthew Slaughter, Vision Product Marketing National Instruments

This is a tough question, as the line between a computer with a frame grabber and dedicated vision systems becomes more and more blurred. There are several applications that today require a PC with a frame grabber simply for the need for more processing power and flexibility. Current PCs can provide up to 3 GHz of processing power across multiple cores, and have as much memory as you care to spend money on. Depending on operating system choice, these systems also allow the flexibility to run more than just vision software, which is not the case in many smart cameras and vision systems. Many PC based industrial vision systems will handle other tasks such as motion control or data acquisition, tasks that a smart camera or dedicated vision system would have a hard time handling currently. It is also much easier to upgrade a PC based system than a smart camera based system, so any system that requires frequent updates would always benefit from a PC and frame grabber based system.

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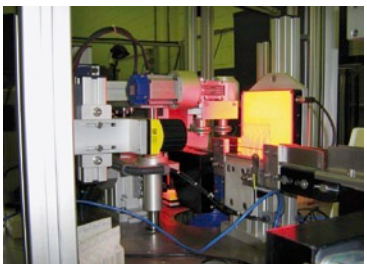

A major pharmaceutical manufacturer relies on Cognex In-Sight vision as part of their inspection machines designed to inspect small vials containing serum as well as detecting even the tiniest impurities within the serum. The In-Sight 5603 proved the only solution for this kind of sensitive high speed inspection. IPF Ingenieria is based in Barcelona in Spain and manufacture special machines destined for high profile industrial customers. Fresenius Kabi needed a special machine capable of tackling the challenge of inspecting small vials of serum. IPF provided them with a machine equipped with In-Sight vision systems from Cognex as recommended and integrated by Cognex partner, Edge Vision. In this application, In-Sight cameras were installed to inspect the levels of liquid in vials of serum as well as inspecting for impurities at a speed of 10,000 bottles an hour.

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Significant Efficiency Increase

Isra Vision is now offering special in-line inspection solutions that allow customers to increase efficiency even more in various segments of the growing solar industry. Formscan-Solar provides a system that makes solar parabolic mirror inspection faster, easier and more precise. These inspections will lastingly benefit energy output, increasing it significantly. Powerscan enables thinfilm solar cells to be inspected efficiently and precisely in an automated process. These inspection systems can be employed throughout various production steps. They optimize the production process, increasing productivity. Manufacturers of solar plants thus achieve high returns on their investment almost immediately. Even in the current 2008/2009 fiscal year, ISRA is expecting significant sales from the new inspection systems for the solar industry.

Isra Vision AG
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Higher Scanning Speed

At the Technology Forum on 11 and 12 February 2009, Viscom will present its successful QuickScan solder paste inspection on a new system platform, the S3088-II QS. The proven special illumination has been integrated into the system S3088-II, along with a new camera technology. Until now, the S3088-II has been offered as a post-reflow AOI with 8M camera technology. Now Viscom exploits the advantages of this system platform for 2-D solder paste inspection as well. The integration of a new camera head especially for paste inspection and a new high resolution line scan camera results in a scanning speed increase of up to 50 %. This combination yields cycle times even lower than those achieved by the predecessor model. Customers who already employ a S3088-II post-reflow also profit from synergistic effects during service and maintenance.

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Color Inspection and Grey-scale Machine Vision

With the Imagechecker AX40, Panasonic introduces for the first time a Machine Vision system which can process grey value images and color images at the same time. This opens new inspection possibilities, because the information given by colors is an important additional image evaluation feature. Thus, e.g., grey value measurements can be combined with an object-recognition in the color image. In addition, a special differential-image mode is available. It is suited particularly for surface inspection and print controls. The software of the AX40 offers all common inspection algorithms of grey value systems and color inspection systems. In total approximately 3,500 inspection combinations are possible. With this scope of so called checkers, the device is suited for virtually all inspection tasks such as assembly control, product differentiations, measurements or the print control.

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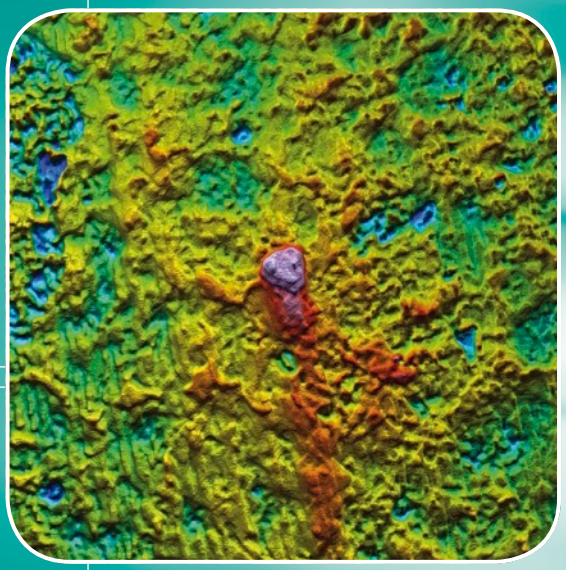
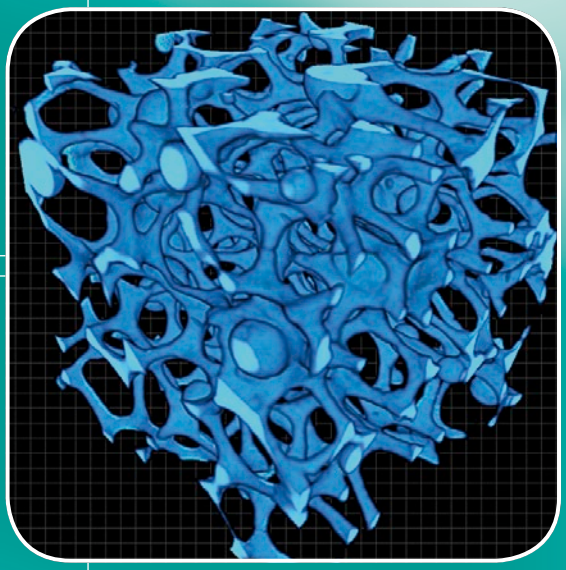
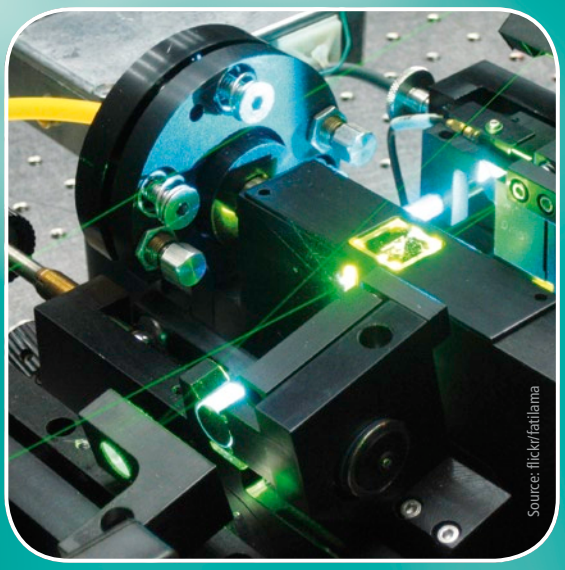
INSPECT

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.

Laser Beam Quality Improves

Digital Wavefront Sensors Measure Laser Beams

Source: flickr/fatilama

Laser beam profiling plays an important role in such applications as laser welding, laser focusing, and laser free-space communications. In these applications, laser profiling enables to capture the data needed to evaluate the change in the beam width determine the details of the instantaneous beam shape, allowing manufacturers to evaluate the position of hot spots in the center of the beam and the changes in the beam's shape.

There is a strong relationship between the performance of the laser in materials processing and the laser beam parameters in the laser material processing zone. However, the design of a laser system with optimum beam quality in the process zone is a challenge. The main tasks involved in the design of an optimized optical system are obtaining a high – quality beam, shaping the beam to the desired properties and transferring it efficiently to the process zone without distortion.

Measurement of Laser Beam Profiles

Besides beam power and polarization, the transverse beam dimensions and their change during propagation are the most important characteristics of laser beams. The transverse propagation properties of any stigmatic beam are fully determined by the beam waist, the distance from the waist and the divergence angle of the beam.

The combined determination of all beam propagation parameters is usually performed by recording the free-space propagation of the beam widths at several planes transversal to the direction of the laser beam propagation, and in the two directions (x and y) for elliptic beams (fig. 1). As the numeric estimation of the beam width is carried out by parabolic fit of the beam's power density, the measurement of the beam propagation factor M^2 is very sensible to the width measurement errors, so that numerous planes are required to obtain a reliable M^2 value. According to the ISO 11146, the measurements of the beam's power density must be carried out at least at five planes within one Rayleigh distance from the beam waist, and at five other planes within the distance twice the Rayleigh distance, $ZR = \pi\, w_0^2/\lambda$, where w_0 is the beam waist, and λ, the wavelength.

The profiles are displayed as contour maps of the beam intensity, a 3D map or a profile. From the beam profile data at several transversal planes and from the parabolic fit of the beam width as a function of the propagation distance z, the beam-propagation factor M^2 is derived, as well as the other parameters characterizing general astigmatic beams: widths w_x and w_y of the waist, distances z_x and z_y to the beam waist, and the orientations ϕ_x and ϕ_y of the beam's principal axes with respect to a reference coordinate system.

The propagation factor M^2 quantitatively compares the propagation characteristics of the real beam to those of a pure TEM_{00} Gaussian beam. For a given input beam width and lens focal length, this comparison allows the exact focused spot size to be predicted, as well as the irradiance of a focused spot, the Rayleigh range over which the beam is relatively collimated, and the far-field divergence of the beam. In practice, images at between 20 and 60 planes need to be taken in order to attain ±5% precision in M^2 value, with sensitivity of ±2%.

Wavefront of a Laser Beam

Wavefront is another characteristic of the beam yielding information about local energy flow within the beam. In a laser beam having plane wavefront, all the energy is

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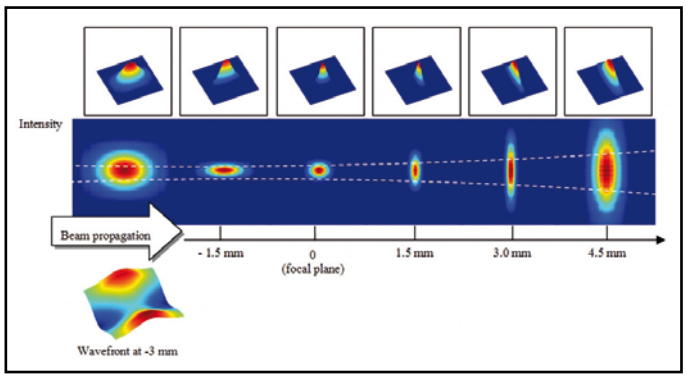

Fig. 1: Wavefront analysis of a laser beam (λ = 633 nm) in one plane allows to predict the beams behavior near focus and compute the position and width of the laser beam waist, and laser beams divergence

flowing along parallel lines, so that the beam stays fully collimated irrespective of the position along the beam's propagation direction. In contrast, focused beams feature concave wavefronts that allow the beam to concentrate the maximum energy in a one place at the waist of the beam. The wavefront displays the direction in which a given segment of a laser or optical beam is travelling. It intuitively and directly displays which components in the beam are contributing to the beam eventually diverging from a straight line parallel collimated beam. In this sense, it presents a more detailed insight than simply measuring the divergence angle itself.

The picture of the wavefront provides intuitive insight into beam structure. Calculations obtainable from a wavefront measurement provide quantitative insight into beam performance. Wavefront measurements provide all the aberrations in the laser beam and use this information to compute the modulation transfer function (MTF), which is used as an indication of the quality of transmission of spatial frequencies of the optical elements in the laser beam's path.

Wavefront information is a valuable supplement to beam profile data. It provides the information necessary to predict possible future beam distribution without having to measure the beam at several transversal planes, thereby allowing better determination of the waist of the beam. It also provides more detailed information on propagation characteristics of the beam in an optical system. Wavefront data provide more precise information on a beam nearing focus, and on the precise position of the beam's focal point along the optical axis.

Digital Wavefront Sensors

Wavefront analyzers currently available on the marketplace can only provide the low resolution wavefront data and, in the best case, low resolution intensity distributions. Therefore, for a comprehensive laser measuring system, both a beam profiler and a wavefront sensor would usually be needed as separate instruments. In these "analog" wavefront sensors, special hardware components transform the light intensity into interferometric fringes (as in shearing interferometers) or in a series of spots (as in Shack-Hartmann sensors), so that the original high-resolution intensity data are lost and can only be captured by an independent camera.

As a consequence, a complete system to measure laser beams using the conventional wavefront sensors and allowing laser beam profile analysis, would consist two distinct instruments: a analog wavefront sensor upgraded to the highest resolution, and a high-resolution digital camera, to simultaneously measure the phase and the intensity of the wave and to predict the behavior of the beam as it propagates, by using numeric routines such as Fresnel propagators. Even with this configuration, low spatial resolution of the existing wavefront sensors precludes accurate measurement of the beam's parameters.

The new Digital Wavefront Sensor of PhaseView measures both high-resolution wavefront and high-resolution intensity data in real-time an in one shot, so that it becomes possible to both measure the important M^2 and other beam propagation parameters and wavefront data by using one system at only one plane transversal to the beam propagation direction. It is especially useful for pulsed lasers were instantaneous beam waist and wavefront measurements are changing at the highest rate.

The term "digital" associated with PhaseView digital wavefront sensing technology means the minimum use of hardware components and the intensive use of specialized algorithms. As technological innovation, the digital wavefront sensing technology is based on the prevalence of software as compared to conventional use of hardware elements to achieve highest wavefront sensing performances.

The digital wavefront sensors rely upon measurements of the energy redistribution in the 3D space: they measure the variation of the electromagnetic wave's intensity in the optical axis direction, while as interferometers, digital wavefront sensors measure the redistribution of the wave's intensity in the transversal direction. Contrary to interferometers however, no reference plane is used in the DWS: the measured object serves itself as a reference.

The measurement of the intensity in three dimensions in real time leads to the high resolution measurement of the wavefront with no use of the hardware diffracting elements or micro-lenses, at the cost of increased computational effort. The evolution of the beam through space is sensed by projecting the beam corresponding to different planes transversal to the optic axis, onto a CCD camera, demultiplexing the images and applying complex fast mathematical differential equation solvers to obtain the beam's wavefront. The resulting optical sensor (fig. 2) is insensitive to vibrations, compact (25 x 32 x 43 mm) and light (0.3 kg).

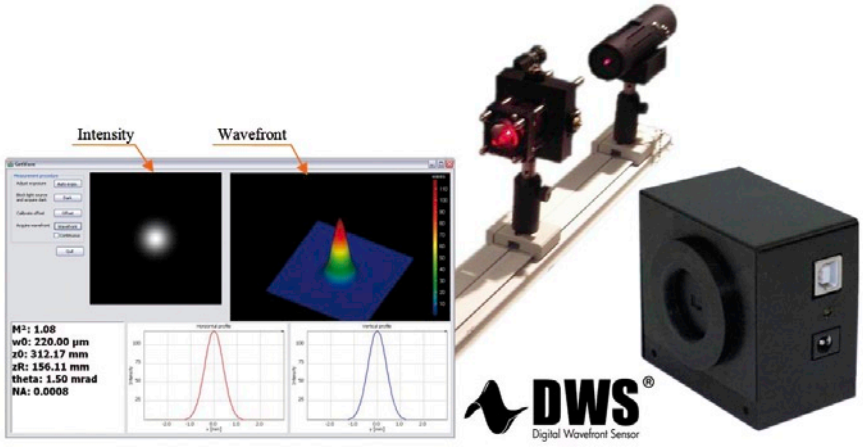

Fig. 2: Digital Wavefront Sensors are used in measuring laser beams to provide information about beam focusing parameters from simultaneous measurement of phase and intensity at only one plane transversal to the beam propagation direction

Although these performances come at the cost of increased computational burden, the measurement frequency of 15 Hz or higher is achieved.

Today's Digital Sensors typically feature sensitivity of λ/100 over entire dynamic range of several hundreds of wavelengths. The resolution of about 250,000 measurement points over the aperture of 6.4 x 4.8 mm is achievable. With no use of hardware elements, digital wavefront sensors suit for measurements in a broad illumination frequency spectrum. They allow measuring slopes, divergence and convergence of the wavefronts, thus reducing the burden on the optical systems and permitting measurement of rapid phenomena. The Digital Wavefront Sensors offer a flexibility in terms of resolution and dynamic range, thus allowing measurement of both higher – order and low – order aberrations.

DWS is interfaced with computer through the USB 2.0 interface. Both CW and pulsed lasers, as well as the focused beams can be analysed to obtain the propagation factor M^2. The focal point position can be obtained for a complex laser assembly. Digital reconstruction of the wavefronts as well as computation of the parameters characterizing the laser beams, are carried out by PhaseView's GetWave software. Following the computation of the wavefront in a plane transversal to the optic axis and without taking more images, numeric computations allows automatic measurement obtaining values for the beam waists w_x and w_y, their positions z_x and z_y with respects to principle planes of the focalisation lens, Rayleigh distances $z_{R,x}$ and $z_{R,y}$, to within 2–4% accuracy with the sensitivity better than 2%. Astigmatism of the beam, its asymmetry and its divergence are also computed.

Digital sensors open up new opportunities for laser beam characterization. Compared to the conventional procedure for the determination of the laser beam parameters by measuring the beam's width as it propagates, the capture of only one high-resolution image and numeric computation allow fast reconstruction of the laser beam profile with superior accuracy thus avoiding a tedious operation of image capture in numerous planes. When used in measuring aberrations (wavefront deformations) in laser beams, the high resolution attained by DWS in wavefront reconstruction coupled with straightforward measurement of light intensity allows predicting the behavior of the laser beam near focus with more accuracy. This enables to determine the exact position of the beam's focusing point, compute the waist and divergence of the laser beam and thus beam-propagation factor M^2 more accurately when the current low-resolution analogue wavefront sensors such as devices based on Shack-Hartmann or shearing interferometers.

Conclusion

High-resolution wavefront sensors help improve the alignment of the optical systems involving lasers, control and predict the shape of laser beams, measure collimation of the beam and detect tiniest aberrations caused by optical elements in the optical setup thus protecting sensitive components of laser chains. Combined with wavefront correction elements and command-and-control system in an integrated adaptive optics setup, they help improve on the laser spot quality.

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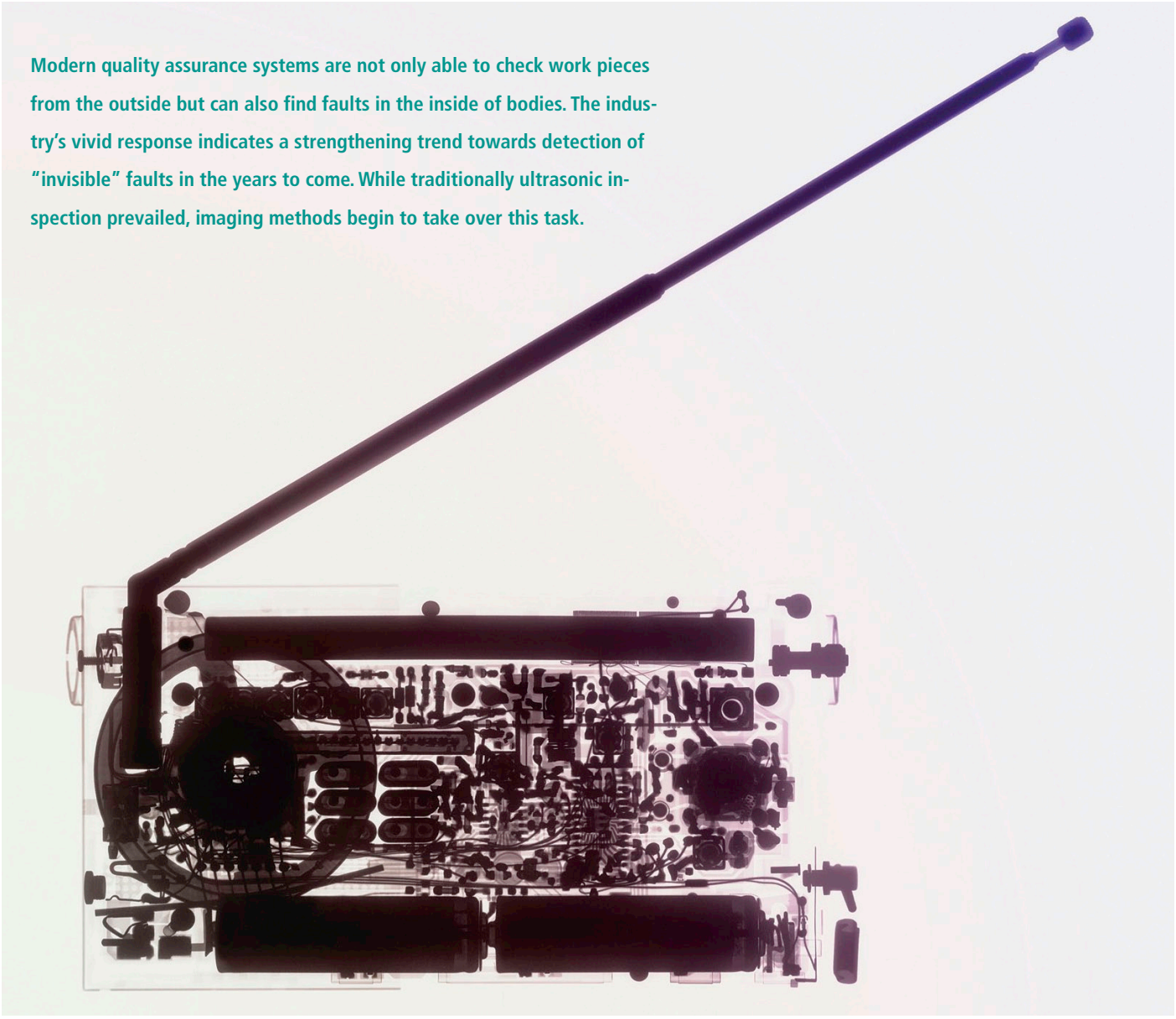

Modern quality assurance systems are not only able to check work pieces from the outside but can also find faults in the inside of bodies. The industry's vivid response indicates a strengthening trend towards detection of "invisible" faults in the years to come. While traditionally ultrasonic inspection prevailed, imaging methods begin to take over this task.

Imaging methods employ technologies using the non-visible part of the wave spectrum, as for example X-ray tomography or heat-flow thermography. Presently, researchers are working hard on the development of the terahertz technology that allows establishing also physical and chemical properties of a non-metallic body. With appropriate bodies, shearography offers itself, using the mechanical surface tension for the detection of faults.

X-ray Computer Tomography

Using X-ray technology, objects of any complexity of nearly all kinds of material can be ray-penetrated and examined for faults. The simple ray penetration method allows examination within seconds even on a conveyor belt. State-of-the-art, however, are tomography systems by which the specimen is screened layer-by-layer, yielding complete data in all three dimensions. This allows looking into the inside of work pieces, revealing faults like pipes, cavities, pores, or ruptures. Combining mechanical or optical sensors to establish values of reference and computer tomography, will allow metrological measuring of interior structures (see fig. 2).

This technology will allow exactly localizing foreign matter in products or foodstuffs as well as exactly measuring below-surface or covert structures such as welding seams or soldering points. Us-

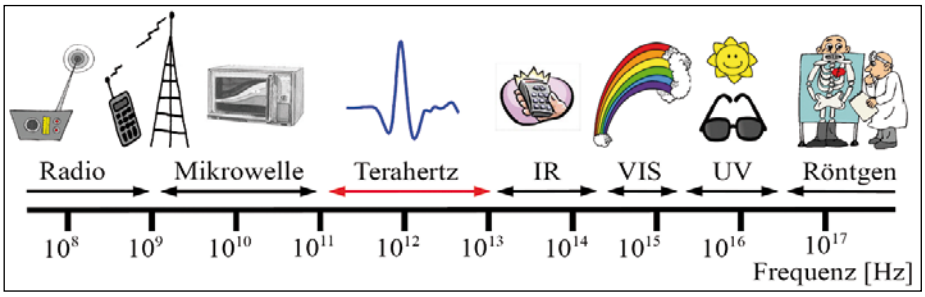

Fig. 1: Wave spectrum Courtesy Fraunhofer IPM

age of modern computer tomography has meanwhile been made possible in industrial applications. Depending on the scope of the measuring task, the duration of measuring today can be reduced to a few minutes.

Improving the integration of X-ray technology into the manufacturing process remains a great challenge. Examination procedures that are presently isolated steps within production need to be integrated into the production flow in the future, thus representing a value-producing production instrument. This way, data gained will not only contribute to quality control but will also allow rapid control corrections in case of faulty production.

Heat-flow Thermography Reveals Faults

Heat-flow thermography utilizes the fact that all bodies emit a spectrum of electromagnetic waves representing their temperature and that below-surface defects will generally hinder heat flow. For an examination, heat flow in the object is utilized that changes its character around faults in a typical way; this heat flow can result either from the manufacturing process itself or can be induced for that purpose. In the latter case, heating radiators, flashlights, lasers, electrical induction, or ultrasound will create heat influx. The lock-in method will yield high sensitivity at an increased measuring duration. Here, sine-shaped heat flux is applied over several periods, their duration revealing the examination characteristics. The dynamics of the heat flow is reflected by the temperature distribution on the surface of the specimen. By using a sufficiently rapid and sensitive thermography camera, the course over time of this temperature distribution can be registered and faults can be made visible (see fig. 3). Lock-in methods will also al-

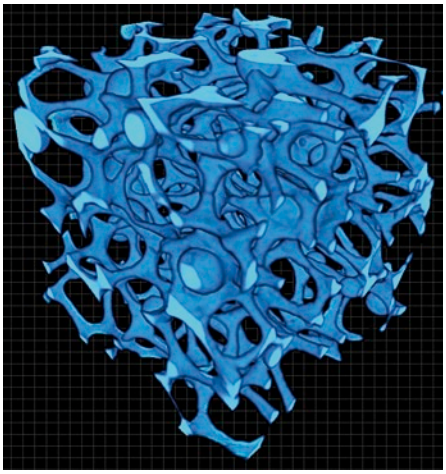

Fig. 2: A take of the microstructure of a piece of aluminium foam by X-ray tomography
Courtesy Fraunhofer ITWM

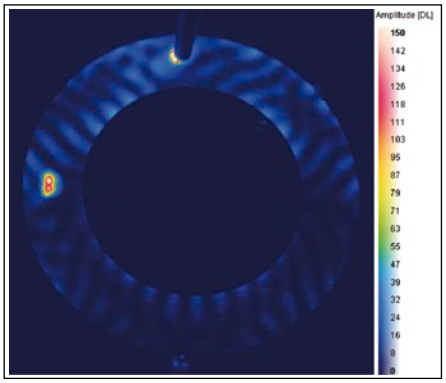

Fig. 3: Detection of a fault on a clutch disk by means of ultrasound-stimulated thermography
Courtesy Fraunhofer TEG

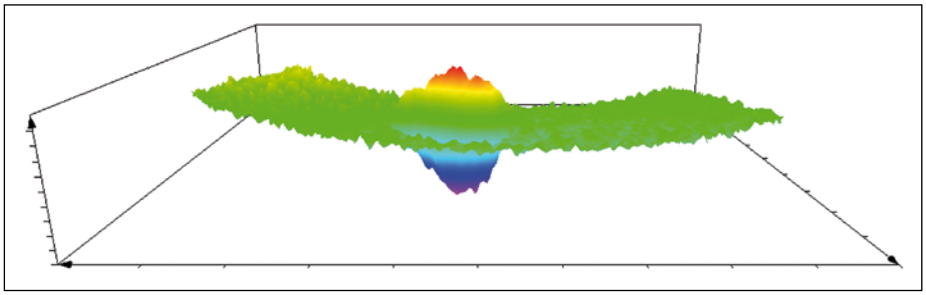

Fig. 4: Three-dimensional rendering of the deformation gradient of a fault in a clutch disk by means of shearography
Courtesy Fraunhofer TEG

low evaluation of the phase displacement relative to its stimulation.

Heat-flow thermography can be applied in the most diverse industrial sectors. It is particularly well-suited for compound materials, for example for the detection of faulty adherence, ruptures, de-lamination, bubbles, trapped air, and corrosion under varnish, as well as for assessment of the strength of welding, cement joints, and soldering.

The depth attainable in searching for faults depends largely on the heat conductibility of the material in question, being generally shallower than with an X-ray inspection. On the other hand, it usually facilitates a shorter measuring time at reduced investment and operating cost.

Shearography for Inline Quality Control

Shearography is an interference-based testing method with which surface deformation can be measured by timing the time of travel of a laser beam. The interferences caused by the reflecting laser beams can be evaluated within seconds. This reveals local variations of rigidity, thus reflects on type and position of defects in the interior of the part.

Shearography allows the measurement of deformations and oscillations within few nanometers and facilitates detection of otherwise invisible faults below the surface. On account of its low susceptibility to malfunction and its high speed at high sensibility, this technology can easily be integrated into production processes. In addition, it will deliver information on deformation under mechanical, thermal, or pneumatic loads, caused for example by variations of temperature and pressure, by a vacuum, by bending or torsion loads or dynamic stimulation. Further applications are the testing of compounded materials, detection of tire defects and visualizing of mechanical oscillation (see fig. 4)

Terahertz – a New Imaging Technology

The terahertz (THz) technology, although being in its infancy, promises interesting perspectives in the future as an addition to the X-ray technology. Possible applications are the detection of faults and foreign matter in a given volume, the measurement of the thickness of layers, delamination testing, or the inspection of welding seams on plastic parts (fig. 5). In particular, the transparency in the THz-frequency range of many plastic materials and ceramics renders this radiation interesting for the quality control on components made of these materials.

In addition to the detection of layer thickness and defects, physical and chemical material characteristics can be registered. For example, it is now possible to attribute, through the packaging, Aspirin tablets to individual manufacturers, or detect hidden explosives. Terahertz radiation will not, however, permeate metal.

One tends to call the terahertz range the "last great challenge within the electromagnetic spectrum", as it is not yet used intensively in technology, as opposed to other frequency ranges. With frequencies between 0.1 and 10 THz this range of the spectrum is situated between microwave and infrared radiation. Pertaining wavelengths range from 3 mm down to 30 µm.

THz radiation combines the advantages of its neighboring ranges of the spectrum – a high degree of penetration with little scattering, combined with good three-dimensional resolution. Also, on account of its low energy, THz radiation is safe for humans.

THz technology today stands before a threshold comparable to laser technology during the nineteen-seventies of the past century. On the one hand, basic questions of physics and technology have been answered and initial applications have been demonstrated, on the other hand the general industrial breakthrough is yet to be achieved. To this end, researchers are working on the development of high-energy terahertz sources, as well as on a fast sensor for data acquisition.

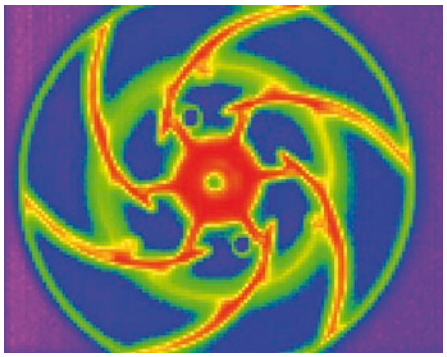

Fig. 5: Examination of welding points of a turbine vane by means of terahertz technology
Courtesy Fraunhofer IOF

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Leica Microsystems Wins Prodex Award

The company has won a Prodex Award 2008 for the development of Fusion Optics. The innovative approach in optics has helped stereomicroscopy to hitherto unknown resolution and field depth and was used for the first time in 2007 in the Leica M205 C. The jury of the Swiss industry award found the simple yet ingenious concept of Fusion Optics so convincing that it gave it second prize.The award was presented for the first time in Basel at the Prodex international fair for machine tools, tools, and production measurement on 20th November 2008. It was organized by the exhibition company Exhibit & More and Vogel Business Media with its trade journals SMM Schweizer Maschinenmarkt and MSM Le Mensuel de l'industrie. Over 30 of the 325 exhibitors had entered a product or service, ten of which had been nominated for the final round to choose the top three prizewinners.

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Multisensor Coordinate Measuring Machines

Back in 2005, Werth Messtechnik presented the world's first multisensor coordinate measuring machine with computer tomography sensors (CT), the Werth TomoScope. With the integration of CT sensors in a mechanically and thermally stable coordinate measuring machine, internal and external features of a component can be determined in a short time with high precision. It is therefore suitable for rapid initial sample production, for example, and also for production monitoring. A modular concept and patent-pending functions make these machines a guarantee for future-oriented solutions.

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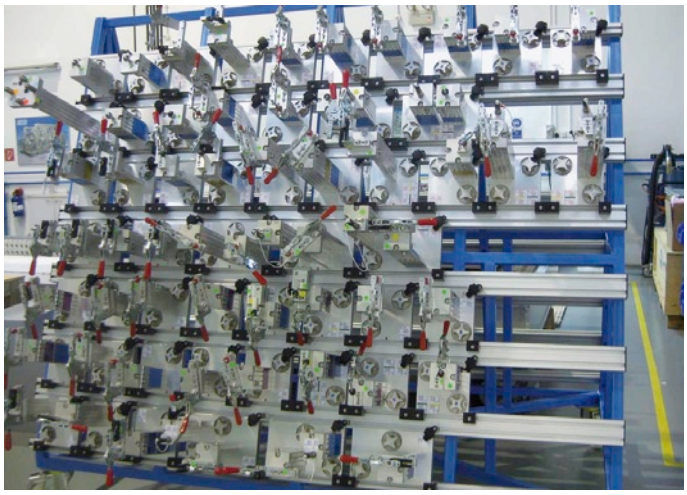
14 Measuring Fixtures on 4 m²



For providing modular, repeatable fixtures Witte Bleckede offers different systems for configuring custom-built solutions. The flexible systems enable over and over again different application possibilities. Recently a project involving exchangeable Megalu columns, an economical alternative for dedicated fixtures, was carried out. Using basic equipment comprising of 120 Megalu columns as well as a horizontal grid plate and a vertical sandwich plate 14 different fixtures were assembled for holding various passenger car body parts during measuring. The columns are equipped with labels which makes identification of a column group for each car part easy. Each individual column is mounted on a small foot plate, which is equipped with a quick change mechanism, so that the Megalu columns can be mounted quickly and easily onto the horizontal and/or vertical sandwich plates.

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Quality Inspection of Flat Glass

Two new measuring stations from Micro-Epsilon are being used to inspect the dimensional accuracy and edge quality of flat glass at Schott based in Jena. Dimensional accuracy is a critical factor in industrial glass, which is used for demanding technical tasks. An example of this is glass used in the production of photovoltaic modules. Even a small deviation from the required geometry or thickness of the glass can adversely affect the function of the glass at a later date. In the production line, a robot places the pane on a transport system, which feeds the pane into the measuring station. Six optoNCDT 2401 confocal chromatic sensors are located on a traversing beam directly above the pane, which measure the thickness and planarity in six tracks. The desired distance or thickness information for the confocal principle is obtained from polychromatic white light.

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Visiona

Interview with Dr. Klaus-Henning Noffz, Executive Manager Silicon Software

INSPECT: Dr. Noffz, you and your partner have founded Silicon Software 12 years ago as producer of frame grabber technology. What was back then the idea behind?

Dr. Noffz: My colleague Dr. Lay and I, both came from long-termed research fields, where we looked into the hardware and software aspects of FPGA technology. The focus of our research back then was already the recognition of pattern, which directed us quickly to the Machine Vision industry. Therefore we didn't trace the market back to technology but vice versa. The original business idea was "how can Machine Vision benefit from FPGA technology?" Even the very first generation of our products has been a frame grabber with included preprocessing capabilities.

Did your initial vision change during the following years of the company's development?

Dr. Noffz: Certainly the idea was modified over the years, but not needed to be basically changed. While an intelligent image acquisition board was exotic in the very beginning, today a hardware based image processing is used very often. In the course of the years it became more important for us, to complete the product family to cover a broader application focus. Nowadays different performance classes of our product lines range from pure image acquisition frame grabbers to demanded preprocessing boards.

In addition to a whole portfolio of frame grabbers, Silicon Software today offers the software product VisualApplets to the market. What is this about?

Dr. Noffz: The product VisualApplets is a graphical tool to program the FPGA very easily. The software unburdens users of complex decisions concerning synchronicity and timing or management of resources, and allows them to focus on the algorithmic processing of the imaging application. VisualApplets comes with a high level simulation, which shows the current visual result on each link of the imaging data flow in bit accuracy. Hereby the software is especially suited for software programmers and application engineers. VisualApplets looks back on a long development history. During research, there were already first ideas how to program larger and more complex FPGA and even multi FPGA systems in the future in a more efficient way.

With the foundation of Silicon Software we started to develop an own hardware description language (HDL), which works noticeably faster and more efficient for image processing applications on the FPGA.

In addition to the functionality of the frame grabber we delivered, more services were asked of us increasingly often to add or modify processing features. At the same time, the interest of the customers in programming hardware by themselves grows, for "time to market" reasons, as well as the need not to disclose their algorithmic know-how. For us, this was the starting point to finalize partly existing internal developments for marketability. VisualApplets became the central product of our company. New hardware developments always regard compatibility to VisualApplets in concept and realization.

Compared to traditional programming methods like VHDL/Verilog, VisualApplets enables a realization of applications in a tenth of the development time in average at similar code efficiency. More than 200 operators of the image processing libraries cover with basic up to complex functionality most requirements in preprocessing. With the availability of blob analysis and pattern matching, we enter parts of segmentation and classification. Other libraries cover functions of complex signal processing, i.e. to realize customized triggers. The wish list of our customers and our own roadmap include more and very interesting features for the future.

VisualApplets is not considered a closed system. The partnership to other companies and products is important for us. We don't see VisualApplets as a competition to imaging software but as a logical completion to avoid performance bottlenecks in the processing. Interfaces to libraries will allow third party compa-

nies to integrate and offer their own FPGA libraries.

Two years ago, we adapted VisualApplets onto intelligent camera hardware manually. With a new product line, we will ease the interface for the integration of VisualApplets on third party hardware. It enables manufacturers of imaging components to use the advantages of VisualApplets even on their own hardware platform.

What is your vision for the development of frame grabbers and machine vision cameras respectively for the next 10 years?

Dr. Noffz: In our opinion, frame grabbers are still needed in the next years. The evolution of sensors is still going on and hardware is required to support. But a frame grabber will not be easily recognized as such in the future. Even today, it is hidden as chip in a smart camera, but still recognized with its acquisition and processing functionality. The same is also effective for cameras. Cameras will have their importance from high-end applications to miniature cameras. But intelligent and application specific sensors will increase their market shares. Industrial image processing will be omnipresent, but not necessarily obvious. That will happen especially in applications, which are not directly concerned to industrial production.

The last 12 years of Silicon Software are a success story. What is your recipe for success and how would you advise young engineers or scientists who intend to set up a vision company today?

Dr. Noffz: Stamina in our branch is very important. That is mainly concerned with requirements of a long-termed availability of products. Therefore a business idea is required, which is and will remain sustainable at least mid-term.

The international network is a further important component, which helps to win broader experiences in projects, applications and partnerships.

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

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