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VISION ▸ AUTOMATION ▸ CONTROL

INSPECT

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Machine Vision and beyond

Machine vision is generally understood as image processing for industrial applications, as opposed to the so-called non-industrial applications of for example medicine, surveillance, traffic, entertainment, to name only a few. However, these areas are also in fact industries, only not production oriented ones. And the term Machine Vision could also be understood as "machines that see", whatever they see in whichever industry or application as long as it is an automated process. This broadening of a definition would directly lead to a huge broadening of what is today considered the Machine Vision Market and a large group of additional players could be suddenly seen on the field.

Is this useful or not? For a trade journal? For an association?

Let's face the question by taking a closer look into these other areas of application for the technologies we usually cover with INSPECT.

The INSPECT issue in front of you is focused on a wide range of different applications beyond production. Besides the target of generating profit quite a few of these applications directly or indirectly provide for a safer world, a cleaner environment or improved medical treatment. The combination of fast 3D stereo tracking with tissue simulation in virtual reality for example allows for the first time ever to practice eye surgery until proficiency is reached like pilots practicing to master the airplane before their first real take-off. With the increase of age-related eye problems if only by the shift in the age pyramid, millions of us will be very happy about this in the future.

A totally different and yet machine vision empowered tool to make our world a safer place is the equally respected and loathed speed control. Speed measurement, number plate recognition and driver face capturing are all optical and machine vision tasks. As much as these curbside boxes cost us frequent drivers and as much as we might curse it for again getting us in the one moment of lowered attention, I think we still agree that thousands of lives are saved because of the presence of these speed cameras.

Recycling is one way to get our energy balance back on track and glass recycling yields especially high potential. Did you know that with each ton of recycled glass the emission of greenhouse gasses is reduced by 200 kilograms? This, however, is only made possible by very fast and highly accurate optical sorting of the secondary raw material.

These and many more equally important equally interesting applications await you on the following pages. Among them also the meanwhile famous Stasi (i.e. Ministry for State Security, German Democratic Republic) puzzle, the vision empowered reconstruction of 45 Million torn or shredded Stasi documents. A topic very intertwined with our country´s recent history, yet not as German as one could think at first glance.

So coming back to the question: does the definition of Machine Vision need to be extended? Why don't you share your thoughts on this and other "vision related" matters with other experts in our newly established INSPECT community at http://network.inspect-online.com.

Looking forward to meet you there,

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NEWS

VISION

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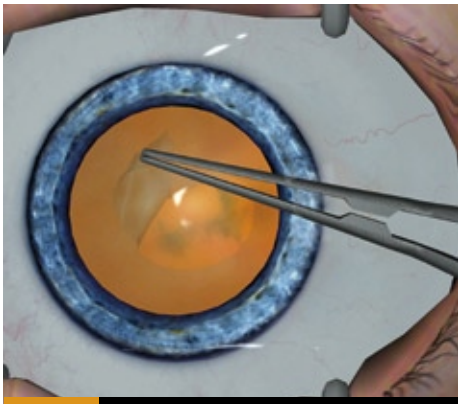
Community ↘ 10



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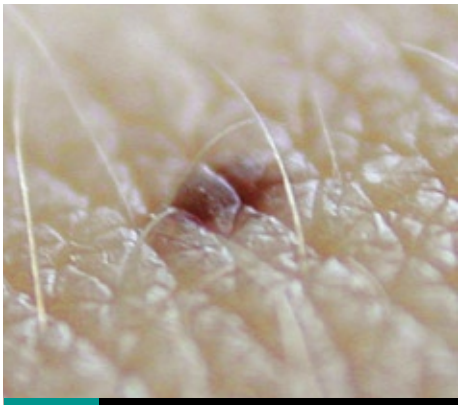

Life Saving
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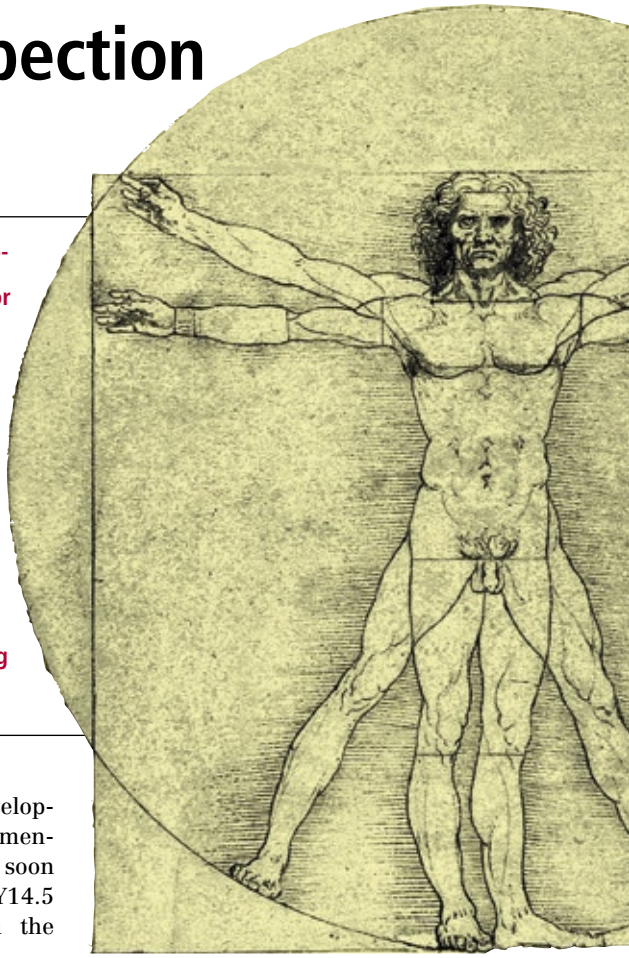
AUTOMATION

CONTROL

A Paradigm Shift for Inspection

Complementing Traditional CMM with DSSP Innovation



Advances in non-contact measurement technology, processes and techniques have created momentum in the application of digital shape sampling and processing (DSSP) for driving a competitive advantage for manufacturing in a variety of industries from automotive and aerospace to consumer products. DSSP has been defined as the convergence of 3D scanning and digital processing of coordinate points by the Society of Manufacturing Engineers in an SME Bluebook authored by Peter Marks of Design Insight and published in October 2005. This paper will demonstrate how DSSP, a potentially disruptive technology innovation, complements traditional inspection methodologies without being disruptive. This paper will also show how inspection is evolving by integrating multiple methodologies to benefit manufacturing productivity and improve product quality to new levels.

A Survey of Technology

When Leonardo da Vinci was designing his advanced machines, there was no concept of manufacturing tolerances or quality inspection measurements. In the 19th century the approach was not different than from Leonardo's time: "cut and try, file and fit".

At the turn of last century, the concept of "Plus and Minus" tolerances was developed and around 1920, the "Taylor Principle" that defined the functional requirement for assembly was introduced. During the Second World War development commenced on geometrical dimensioning and tolerancing (GD&T) and soon thereafter, 1957 saw the light of Y14.5 which evolved to prominence in the present day (ASME Y14.5-1994).

Historically, manual gauges have been used as main tools in metrology, from go/no-go (hard) gauges (such as a simple pin with a given diameter to determine fit), to numerical manual calipers to take measurements from point to point. Hard gauges come in different sizes for different applications, including measuring small turbine blades, car doors and airplane doors. The process includes the use of reference geometry (datums) to position the part to be measured, and then using pass/fail hardware (pins, contact pins, etc.) to measure key characteristics. While very easy to use, the hard gauges are not flexible to accommodate design changes and generally provide only qualitative information (pass/fail) rather than quantitative information (numerical value).

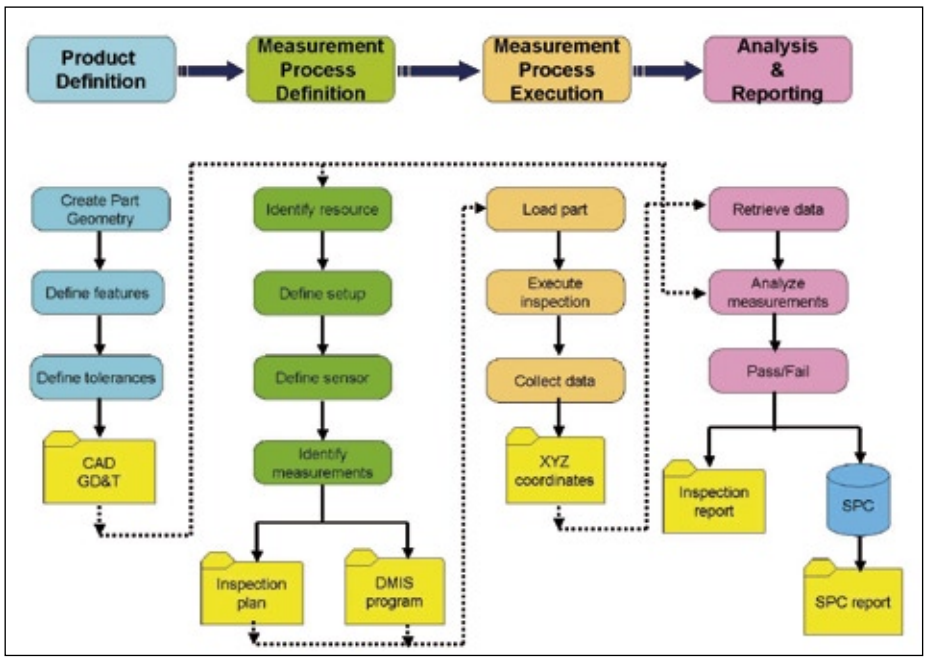


Fig. 1: Traditional CMM-based inspection workflow diagram

In the past 30 years, coordinate measurement machines (CMMs) were introduced, and now are widely used to take measurements in the manufacturing industry. A CMM is a programmable 3–4 axis machine that, through the contact of a touch probe, follows a path to inspect a part at predefined points. Adding accuracy, repeatability, automation and flexibility, CMMs are being used to measure small parts as well as large parts, with generally very high accuracy. They are quite expensive, but they are also quite flexible in their ability to be programmed to inspect virtually all types of parts.

Using CMM in a typical method, a series of characteristics is planned to be measured and an inspection program is created to measure those identified characteristics. The drawback of the CMM

method is that, in only collecting one single point at a time, the point-collection process results in a relatively slow measurement process. Due to inherent time constraints in this process, often only a few critical characteristics can be measured, and as a result, some inspection risks are taken to maintain required production levels.

Photogrammetry has a history of being used to measure terrain and distances for GIS and volumes of buildings – in AEC and archeological applications. The technology, based on techniques of measuring objects from photogrammes, has evolved and increased in accuracy over time so that it is effectively used in measuring large, mechanical objects (e.g. ships and airplanes). However, in the discipline of Quality Assurance where accuracy is of utmost importance, the limitation of insufficient accuracy realized in metrology applications is a critical factor.

Recently, new non-contact measurement technologies that use scanning hardware and processing software to digitally capture physical objects and automatically create accurate 3D models are increasingly used and deployed in the area of metrology. Such techniques converging with the advances in software to process and model from coordinate points are classified in the category of digital shape sampling and processing, or DSSP. The technology underlying DSSP uses lasers, or structured light, to calculate the position of given points; the result of the scan is typically a pointcloud consisting of millions of xyz coordinate points representing the shape and the geometry of the scanned object. The process is very fast and can scan entire object shapes in just a few minutes, with good accuracy that can be used in most metrology applications.

Traditional Measurement Process

The current traditional measurement process, performed with a CMM for example, can be summarized in the following steps as discussed, presented and formalized at the International Metrology Interoperability Summit, (March 28th-30th, 2006) organized by NIST.

- Product definition
  - Create a part geometry
  - Define features & tolerance
    - Output is a 3D CAD model with complete GD&T information
- Measurement process definition
  - Identify resource(s)
  - Define information for setup
  - Define information on sensors
  - Identify characteristics to measure (GD&T or Dimensional Tolerances)
  - Generate inspection plan
    - Output is an inspection plan (text document or similar)
    - In case of a programmable CMM, an inspection program is also generated
- Measurement process execution
  - Load part on inspection device
  - Execute inspection plan
  - In case of a programmable CMM, a program is executed
  - Sensor collects data
    - Output is an XYZ coordinate of the inspected features
- Analysis & Reporting
  - Retrieve actual points
  - Analyze characteristics
  - Determine pass/fail
  - Generate Measurement report
  - In case of multiple inspections, generate statistical analysis
    - Output is a measurement report
    - In case of statistical analysis, output is an SPC report

The above steps are summarized in the workflow diagram in figure 1.

Although the number of key characteristics to be measured typically varies, this workflow is based on three main steps: a) identifying the key characteristics of the part to be measured; b) measuring them; and c) providing an analysis report of the resultant data.

"First article inspection" is an inspection of all the dimensions that can be determined on a drawing. It applies typically at the beginning of the production and the objective is to validate the repeatability of the process to produce the same part over and over. It applies to casting, moulding, stamping and machining. The measurement process used requires a significant investment in the number of times to take measurements. By being so comprehensive, it is inevitably very expensive.

Conversely, during regular production, which is geared to monitor the process and to validate the main key charac-

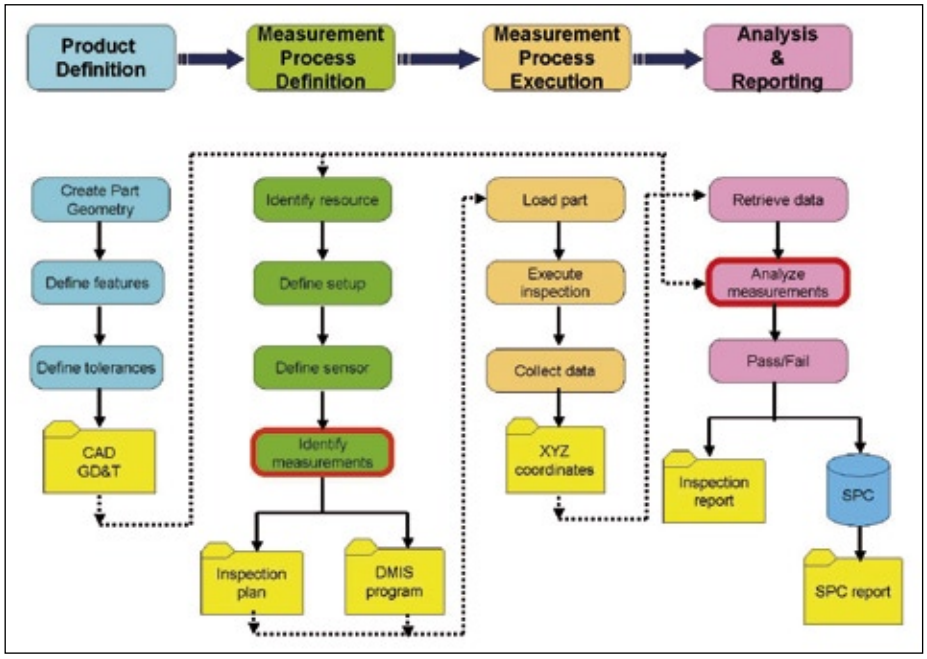


Fig. 2: Identify characteristics to be measured and analysed

teristics, fewer characteristics are inspected.

In both cases the measurement process is strongly driven by the identification of the characteristics to be measured and analyzed, as shown in the diagram in figure 2.

On the processes of measuring key characteristics, several issues may be studied.

For an inspection plan from which all possible key characteristics are measured, the following questions may be raised:

1. Why spend a long time on a CMM inspecting characteristics that might be within the design tolerances?
2. Why spend a long time analyzing all the inspection data to determine which characteristic is in, and out, of tolerance?
3. How can the inspection time be accelerated while measuring the entire object?

For an inspection plan from which a subset of key characteristics is measured, the following questions may be raised:

1. How can it be determined which characteristics have to be measured and which do not?
2. What is the result if some of the characteristics that are out of tolerance are not in the inspection plan?
3. How can characteristics that are out of tolerances be related to a wrong alignment?

A Paradigm Shift

Digital shape sampling and processing (DSSP) offers the capability to capture the entire shape of an object very quickly and accurately. This capability can currently be used during the measurement process to dramatically reduce time to collect dimensional data of an entire object (reduction up to 95%), and to analyze the geometry of the object compared against nominal CAD geometry. Even though millions of points are captured to fully and accurately describe the shape of the object, the process only takes a few minutes.

A quick, 3D comparison of the captured shape against the nominal CAD geometry is performed and displayed on a computer screen using colour maps, such as the turbine blade shown in figure 3.

It becomes quite obvious to an engineer that the areas whose colour departs from the green are areas where the actual geometry departs from the nominal geometry. The darker the red, the further the deviation from the nominal – in terms of positive, and therefore more material – thus resulting in a wider blade. In terms of the opposite: the darker the blue indicated, the further the deviation from the nominal geometry – in terms of negative, and therefore less material – thus resulting in a thinner blade. The above analysis can easily be achieved in a fairly expedient manner (typically under 30 minutes); including: setup, scanning and analysis.

From the first analysis of comparing the captured turbine blade shape described by millions of points, further analysis can follow such as:

- GD&T (geometrical dimensioning & tolerancing) analysis to locate the deviation from a datum reference frame
- thickness analysis to locate critical thin walls, or
- airfoil analysis to analyze the main characteristics of the airfoil.

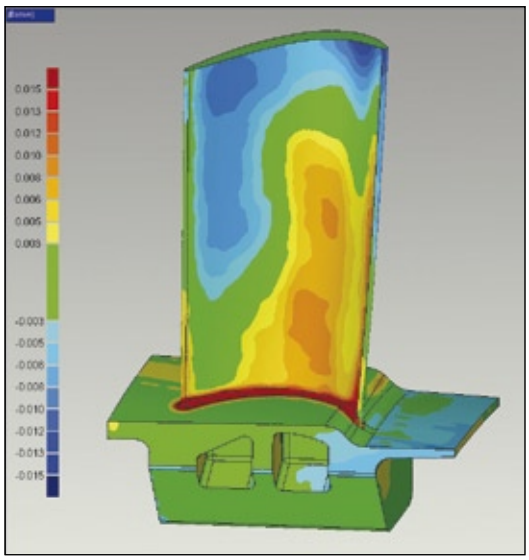


Fig. 3: Deviation colour map of a turbine blade

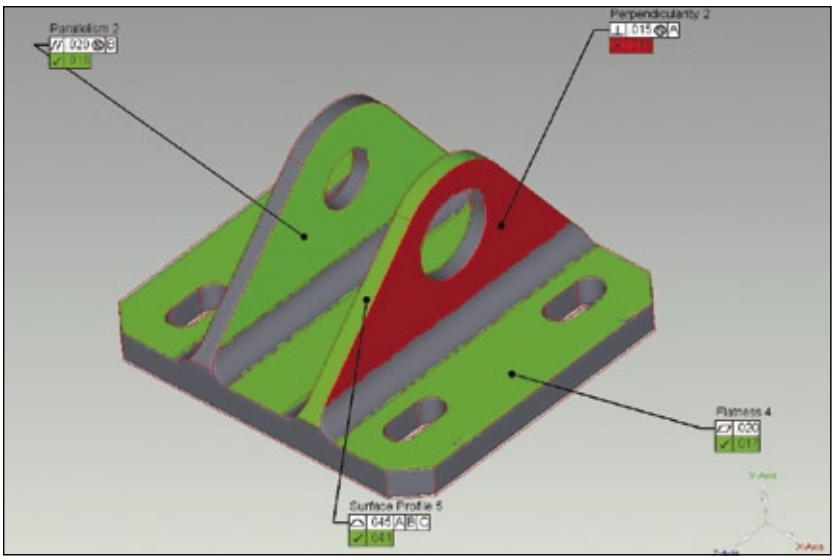


Fig. 4: Graphical representation of measurement data

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Innovation in Imaging

The investigation and analysis is therefore focused on only the areas that deviate the most from the nominal geometry. This then minimizes unnecessary time and resources applied to measuring and analyzing areas that are obviously within tolerance to the desired nominal geometry.

With this new method, subsequent measurement and analysis of a part can focus primarily on the characteristics that are out of tolerance. Measuring coordinates and characteristics in a predefined and preplanned CMM program for measurements that are in tolerance is no longer necessary. Eliminating the unnecessary saves time and increases productivity.

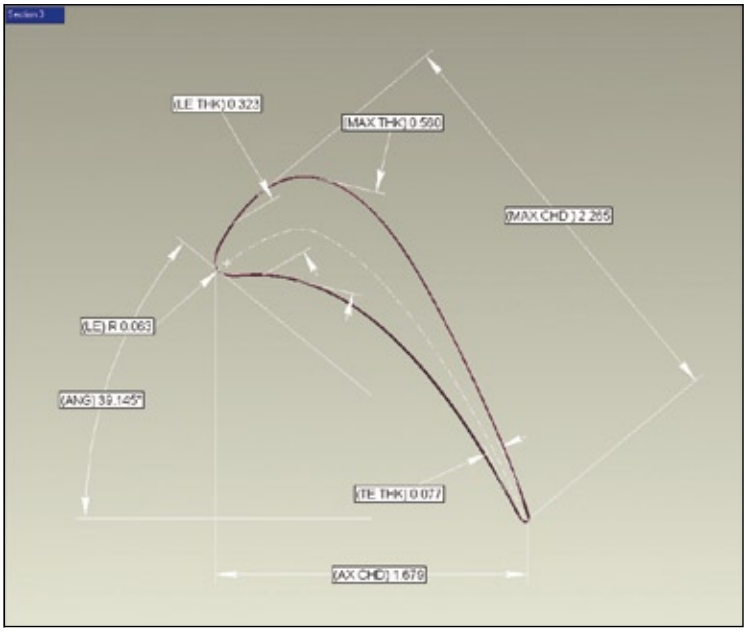

Fig. 5: 2D sectioning and dimensioning

Turning Data into Information

Another major advantage offered by the DSSP technique is that it helps engineers to quickly interpret measurement data and shift from data collection to information analysis.

Using CMMs, hundred of points are collected which typically results in a list of nominal coordinates (x,y,z) and actual measurements (x1,y1,z1). Data in this form must then be processed, grouped and graphically represented so that engineers can quickly determine if a part passes or fails the dimensional inspection (fig. 4).

Taking it one step further, analysis of the resulting inspection data can drive change and process improvement. From information of inspection reports for failed parts, analysts can determine what are the causes of the out-of-tolerance measurements and, more important, what corrective actions are necessary to restore the process to producing parts in tolerance?

Using traditional inspection data, stored in databases and spreadsheets as numbers in tables and records, engineers spend hours, days, and sometimes weeks retrieving and massaging that data, to understand and compare it with CAD data and then documenting the analysis using tools such as Microsoft Word or Microsoft PowerPoint.

The time it takes from detection (of the process fault) to correction (of the process) is critical as the stopping of production is very expensive.

By capturing the full shape of the object and generating graphical reports that are easy to interpret, DSSP enables engineers to quickly focus on the manufacturing issues – providing information to the decision-maker at the right time, in the right format and rich in content rather than as large, useless amounts of data. In addition, colour maps of 3D deviation, GD&T analysis, more traditional 3D dimensioning and wall thickness analysis can be combined with 2D sectioning and dimensioning to more easily correlate with blue-printing and ballooning (fig. 5).

The inherent nature of DSSP producing digital and graphical data, easily and automatically compared to CAD data, eliminates the manual data-processing step and minimizes the time it takes from detection (of the process fault) to correction (of the process).

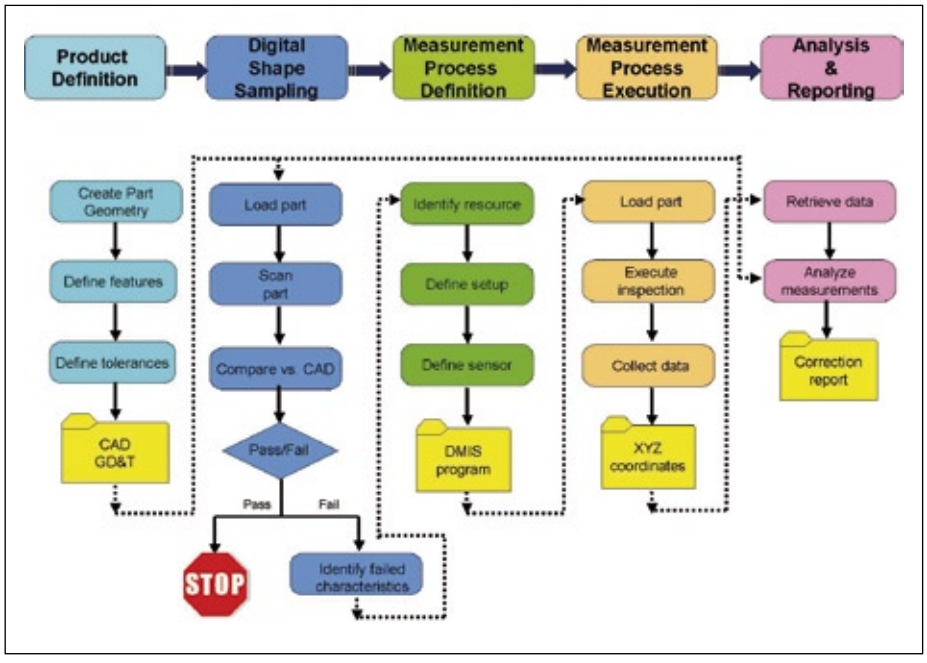

Fig. 6: New DSSP-based inspection workflow diagram

How DSSP Can Complement CMMs

Thus far, three major points have been introduced in this paper:

1. Traditional measurement techniques that are CMM-dependent are based on a workflow that identifies the features to inspect and analyze, regardless of whether or not they are within or without tolerance.
2. DSSP techniques can capture shapes of objects very quickly, identifying the critical dimensional areas.
3. DSSP reporting provides valuable, interpretive information to the decision maker, rather than bare, unintelligible data.

How can modern measurement techniques take advantage of these three points; merging them into an efficient, faster and economical measurement process?

The measurement process needs to change to take advantage of the faster

DSSP process as well as more precise, and therefore accurate, CMMs.

The selection of the features to be measured has to be different. Rather than measuring all the characteristics, the new process needs to measure and analyze only the characteristics that are needed; i.e. the critical measurements that are out of tolerance. The logical concept is predicated not on spending time and money in measuring what is already known to be within given tolerances; but instead, focusing only on what is known to be out of specification and needs to be corrected (either changing the process or re-machining the part).

In this approach, the steps are rearranged as follows.

- Product definition (unchanged)
  - Create a part geometry
  - Define features & tolerance
    - Output is a 3D CAD model with complete GD&T information
- Object shape capturing (DSSP)
  - Scan the part
  - Compare against nominal
  - Identify failed characteristics
  - Generate first analysis report
- CMM Measurement process definition
  - Identify resource(s)
  - Define information for setup
  - Define information on sensors
    - Output is a shorter inspection plan (text document or similar) focused on failed characteristics only
    - In case of a programmable CMM, an inspection program is also generated
- Measurement process execution
  - Load part on inspection device
  - Execute the inspection
  - Sensor collects data
    - Output is an XYZ coordinate of the inspected features
- Analysis & Reporting
  - Retrieve actual points
  - Analyze characteristics
  - Generate Measurement report
  - Determine corrective actions

The above steps are summarized in the workflow in figure 6.

Summary

A new measurement process, based on DSSP technology, is complementing, improving and revolutionizing the traditional CMM-based measurement process.

Using laser-based and/or white-light technology, the measurement process, while being much faster, also provides a more complete description of the shape. Out-of-tolerance areas are graphically displayed with deviation colour mapping, making very quick and easy the possible identification of critical out-of-tolerance areas. Only for this critical area is a more in-depth inspection process required along with proper inspection planning.

The paradigm shift in inspection planning and execution provided by DSSP technology allows customers to measure what is really dimensionally critical, saving time and money not inspecting what is either in tolerance or not critical.

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See and Being Seen

This is Where the Industry Meets: INSPECT Network

Xing is, according to their own statement, the European market leader in business networking. Over 6 million business professionals use Xing in 16 languages to do business and promote their career. The platform makes networking and professional contact management simple, with made-to-measure networking functions and services.

Xing allows to see how people are connected, which is an excellent tool in generating new contacts. With features such as Xing Marketplace, over 17,000 groups and networking events from London to Beijing, it has developed from a contact platform to a web interface for business professionals around the world.

INSPECT Network

However, there is still room for dedication to a certain industry and their demands. With this in mind, INSPECT started just recently a specialized branch community at http://network.inspect-online.com, focusing on Machine Vision and Optical Metrology. The INSPECT network was created as platform to exchange opinions between experts and aims to become the industry marketplace. In the first two weeks almost 100 professionals joined the network: CEOs, managing directors, professors, engineers, sales & marketing managers and other experts. Every new member needs to be approved by the INSPECT team, so that only professionals from our industry will become part of the network.

Features

Members of the INSPECT network can invite industry friends and can participate in discussions. They can upload own videos and pictures, for example photos from trade shows or from company products and it is possible to post explanatory picture captions. This is an elegant way to launch information about own products or own events.

Within the network members can join existing groups or create their own groups for themes which are of common interest and which are not already covered by other groups.

Sales managers can address new customers and stay in touch with existing customers, if only by hoisting the company flag. Engineers can discuss state-of-the-art technical topics and form virtual groups for problem solving. Users can contact potential providers directly and personally.

As also learned with Xing, business networks are an excellent platform for career moves. The INSPECT network is of course much more focused on openings in our industry than any general network can ever be.

In the run-up of an event, people can exchange opinions, start discussions or make appointments with other network members. In addition, it is transparent who announced their attendance to a featured event.

Yet another possibility to contribute to the network are own blogs within the network. New blog entries are visible at the start page for all community members.

In the run-up of an event, people can exchange opinions, start discussions or make appointments with other network members

At http://network.inspect-online.com you will be able to meet other experts of machine vision and optical metrology, get new contacts and intensify existing relationships. Take part and profit from the insider networking about industry trends, technologies and events. Register today at http://network.inspect-online.com.

Theme Groups

The network was launched including four groups, each dedicated to a topic of interest:

World of 3D: Exchange platform for information, ideas, insights about 3D measurement, digitalization, robot vision, inspection and the multitude of technologies involved.

Vision: Everything here circles around cameras, software, lenses, illumination, frame grabbers, vision sensors, smart cameras, embedded systems, interfaces, processors, cables, peripherals, and, and, and … This theme group aligns with the topics from the Vision section of the INSPECT magazine.

Automation: This section, as the Automation section in the INSPECT magazine, features information, discussions, Q&A and more regarding machine vision turnkey systems and applications for all industries.

Control: Optical measuring technology in industrial applications can be found in this group, analogue to the Control section in the INSPECT magazine.

Only two weeks after the initial launch a new group was initiated, which is not moderated from the INSPECT editorial team.

The World of 3D group is an exchange platform for information, ideas, insights about 3D measurement, digitalization, robot vision, inspection and the multitude of technologies involved

The Group „Applied Research" was created by Prof. Dr.-Ing. Volker Lohweg with the group description: Exchange platform for information, ideas, insights about Image Processing and Pattern Recognition in the world of University related applied research.

The Vision community network at http://network.inspect-online.com is yet another information channel provided by INSPECT for the vision community. It aims to complement the INSPECT magazine as well as the INSPECT portal at www.inspect-online.com and provides, in addition to both, the opportunity to directly network among professionals.

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GIT Verlag, Darmstadt, Germany
http://network.inspect-online.com

Innovalia Metrology Presents an I++/DME Seminar

The I++/DME standard is focused to enable interoperability of Coordinate Measurement Machine (CMM,) and metrology software from different manufacturers. The seminar will be held in Brussels on September 25.

The standard has been promoted by major auto manufacturers like Volkswagen, BMW, Porsche, Opel (General Motors), Audi, Volvo and DaimlerChrysler. Innovalia Metrology, an organization particularly active in the development and implementation of this standard, offers a new I++/DME course, which aims to provide a set of theoretical and practical knowledge about it and its implementation.

The course is directed to professionals of dimensional metrology, engineering students wishing to move into a specialization in advanced metrology, and hardware and software dimensional metrology developers. The course will be taught by Toni Ventura-Traveset, director of the company DataPixel, who has participated in the international I++/DME committee.

www.innovalia.com/metrology

Competence Network Combines Automation and Industrial Image Processing

SIM Assembly Machines and Vitronic now offer their clients packaged know-how after forming a competence partnership. Projects such as automation and image processing can be put to work smoothly with the help of a single competent partner offering everything, from planning to implementation, from one source. The two companies will work on joint projects and as a partner will take care of all client concerns. SIM supplies assembly, handling and testing systems and automation solutions. Vitronic provides two and three-dimensional machine vision and measurement solutions.

www.vitronic.com

Edmund Optics Expands Global Presence into the Mediterranean

Edmund Optics has announced another expansion of its global sales presence with the opening of a new office in Rome, Italy, covering southern Europe and the Mediterranean. Allan Kreutzer, VP of Global Sales, commented, "If you want to sell product, you need to physically be there as a full-service provider, fluent in the local language." Beate Sauter, fluent in several languages, joins as the first Regional Sales Manager for the Southern Europe and Mediterranean territories. The Company also plans to open an additional sales office in France during 2008 to support their growing global customer base there.

www.edmundoptics.com

EMVA Relaunches Website with More Resources, New Functionalities, Improved Navigation

The European Machine Vision Association (EMVA) has relaunched its website. The EMVA provides a wide range of information relevant to machine vision applications, technology and industry. Users can now find even more resources and the navigation has been improved to ensure intuitive and simple access to the required information. New functionalities such as the uploading of press releases, case studies and product descriptions and search options further increase its useability. This ensures frequently changing and growing content.

www.emva.org

Allied Vision Technologies Opens New Production Facility

Allied Vision Technologies opened its new production facility at the company's headquarters in Stadtroda at the beginning of 2008. Production capacity has been doubled in order to keep pace with market demand. The second phase of construction to add new office space has just been completed. Over 1,000 square meters of space was added to expand capacity for camera production, quality assurance and inventory. The company also modernized its production process and logistics, creating an all-new, fully automated, state-of-the-art PCB assembly system and two new automated, high-rise storerooms to streamline logistics.

www.alliedvisiontec.com

Cognex Opens Strategic Office in Vienna

Cognex opened a new strategic office in Vienna on 30 May 2008. With its new sales centre, the Company is sending out a clear signal beyond Austria's borders to the markets of Eastern and South-Eastern Europe. It has its sights focused on countries such as the Czech Republic, Slovakia, Hungary, Poland and Romania. The new office will act as a link to Europe's centres of technology, giving these countries better access to vision technologies and keeping the channels for knowledge transfer as short as possible. The selection of Vienna as a location was thus also based on strategic considerations.

www.cognex.com

Polytec France is New French distributor for EVT Eyespector

Polytec France and EVT have formed a partnership that will enable the latter company to position the Eyespector systems perfectly in the French market. As a strong representative, Polytec sells and supports the hard- and software of the Eyespector machine vision systems. The ability to offer application and implementation training as well as to conduct preliminary studies complete the cooperation.

www.evt-web.com
www.polytec.fr

Point Grey Research Relocates German Office

Point Grey Research GmbH has moved to Schwieberdinger Strasse in Ludwigsburg, Germany. At almost double the size, the new office is much larger than the previous office located in Munich, which will provide more space for existing employees, and allow continued growth of the European sales and support team. Customers can expect to see more efficient sales channels, faster response times and enhanced technical support as a result. The Company is continuing to recruit highly qualified employees in sales and technical support who will be dedicated to servicing their customers in Europe.

www.ptgrey.com

VRmagic Joins MVTec Image Acquisition Partner Program

With release 8.0.2 of its image processing software, MVTec now provides an interface to cameras from VRmagic. Christoph Zierl, Development Manager at MVTec, was full of praise for the fast software integration by the development engineers at Vrmagic who took just 10 days to program a complete interface. "Both products are well documented and highly structured, and this meant that it was possible to achieve fast integration," commented Thomas Ruf, Development Manager at VRmagic, who was also extremely satisfied with the excellent cooperation.

www.vrmagic.com
www.mvtec.com

sensors - cameras - frame grabbers - processors - software - vision solutions

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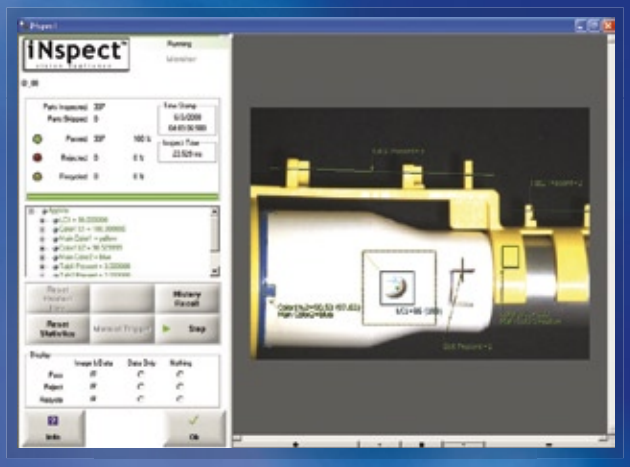

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DALSA

Vision Show and Conference 2009 in Phoenix

The Vision Show, North America's largest machine vision trade show and conference, will be held in Phoenix, Arizona, at the Phoenix Convention Center, March 31–April 2 2009. This is the first time the show will be located in Phoenix, chosen for its high concentration of semiconductor manufacturing companies (ranking 4th in the nation), the growing number of federal defense contracts held, and because of significant aerospace exports, an industry increasingly relevant to machine vision and imaging. The trade show is free for advanced registrants, and the conference offers low-cost passes.

www.machinevisiononline.org

Kappa and Linos Establish Sales Partnership in the UK

The extensive Kappa opto-electronics rugged CCD cameras and image processing portfolio is now available from Linos after agreement on a sales partnership in the UK. This includes cameras for integration, as customer-specific versions or as complete image processing solutions. The first promising contacts had been made on a shared booth at the IPOT exhibition 2008 in Birmingham, one of the most important UK trade shows for image processing and process automation. Numerous specific requests indicated a great demand in the UK.

www.kappa.de

Isra Vision Transforming Growth Dynamics into a New Organizational Structure

For the last ten years, Isra has been undergoing strong growth. During the last fiscal year, the Group reported sales volume in excess of 50 million euros. Sales are projected to double by 2012 at the very latest. Isra has restructured its Industrial Automation division to assure that its organization is always geared towards the needs of its customers while the Group is adjusting to its dynamic growth. The General Industries business unit, which merges the operations of Robot Vision, Components, OEM Business and Quality Vision together with the units Food & Packaging, Automotive and Metronom Automation GmbH, which was acquired at the beginning of the fiscal year, will be integrated to form the division Industrial Automation, each as separate business units. Holger Hofmann, who was successful in expanding the business unit "Integrated Systems", was assigned head of the division "Industrial Automation".

www.isravision.com

Allied Vision Technologies Acquires Prosilica

Allied Vision Technologies is acquiring 100 % of the shares of the Canadian camera manufacturer Prosilica Inc. as of 31 July 2008. The participants have agreed to keep the purchase price confidential. A result of this acquisition is the creation of a wide product range of GigE and FireWire products, extending the market position in digital cameras for industrial image processing. In future, the technology teams of both companies will be working on the further development of both FireWire and GigE interface camera systems, which will be sold under the brand names already established for the two companies.

www.alliedvisiontec.com
www.prosilica.com

Cognex Claims US Patent Violation Against MVTec and Fuji

Cognex has filed a complaint against MVTec Software GmbH, a German company, MVTec LLC, the US sales and support center of MVTec Software in Boston, MA, and Fuji America Corporation, a US subsidiary of Fuji Machine Mfg. "One of the important values within business is to understand the concept of fair competition", says Dr. Olaf Munkelt, managing director of MVTec Software GmbH. "Part of these values is to respect intellectual property rights", he adds. "MVTec is ready and committed to defend itself as well as its customers against these claims because we believe these claims to be unfounded. MVTec has spent a great amount of resources over the years to invent, develop, and to patent machine vision technology", he says.

According to the complaint, Cognex alleges that MVTec's product Halcon violates several US patents of Cognex related to matching technology which is one of the core technologies used widely in machine vision. Fuji, as one of the prominent manufacturers of semiconductor equipment, is claimed to infringe the same Cognex US patents because it allegedly uses Halcon in its machines.

www.mvtec.com

Faro Receives the 2008 Industry Award

Faro has been honoured with two significant awards: 'Top Employer for Engineers in 2008' and the '2008 Industry Award' (category victory for the Quantum series FaroArm).

Siggi Buss, Managing Director of Faro Europe, sees the awards as a confirmation of both the company's philosophy of technological expertise and its efforts to provide its employees with a perfect working environment. The Company excelled in particular in the test criteria of international character, salaries, work-life-balance, development possibilities, corporate culture, job security and innovation management.

www.faro.com

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Tackling Back Pain

Digital USB2.0 Camera Replaces Analog Frame Grabber

Source: Flickr, inequity2007

In Germany ,every second person over 30 years of age has back problems. Back pain has become so widespread that it is meanwhile the most common cause of inability to work and early retirement. And the patients are younger and younger: Children are diagnosed with postural deformity, tilted pelvis, scoliosis or kyphosis already at preschool age. This calls for urgent action. To help physicians find the exact cause of the pain and prescribe effective therapies, Diers International GmbH has specialized in the development of new examination methods: The three- or four-dimensional measurement of the spine with "Formetric." This method takes a stereographic image of the back with a high-resolution USB camera from IDS.

Fast, contactless and radiation-free, the Formetric 3D/4D analysis system examines the correlations of the body statics. A grid is projected on to the patient's back with a light beam and scanned with a camera. From the image the system calculates anatomical landmarks, such as the seventh cervical vertebra or the "pelvic dimples," and derives the spine posture from this data at an accuracy of 1 to 2 tenths of a millimeter. Be it blocked vertebrae, herniated disks, tilted pelvises, static pain or postural syndromes—the results of the Formetric go far beyond the findings achieved with conventional X-ray, computer tomography and magnetic resonance imaging technology, and ensure a high success rate for the prescribed therapies.

Avoid Cancer Risk

Diers International GmbH started the "Static 3D measuring process" research project approximately nine years ago, in close cooperation with leading universities and the European Union. The objective at that time was to develop a radiation-free biomechanical measuring method which was particularly intended to spare children with scoliosis from frequent X-ray exposure. Clinical trials had shown that the children had a much higher cancer risk due to the X-ray examinations, which were necessary every 3 to 6 months. The most widespread system for three-dimensional optical spine and postural analysis today, the formetric measuring method is used in hospitals, rehabilitation centers and orthopedic practices worldwide. It is suitable not only for screening, monitoring and measuring the results of therapeutic measures, but also for medical opinions and many other application areas.

A complete 3D model of the spine is reproduced from the stereographic image of the back taken with a uEye camera from IDS

▼ The "Formetric 3D/4D" today is the most widespread system for three-dimensional spine and postural analysis

From 3D to 4D

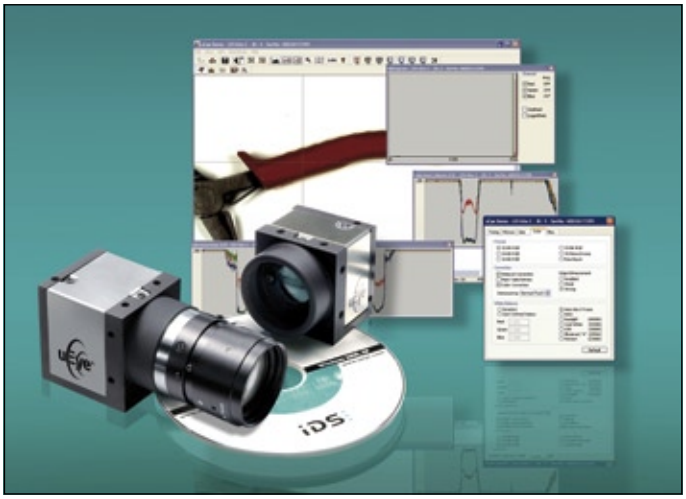
With the help of special software, the static measuring method can create a complete 3D model of the spine from the captured image of the back surface. The method offers even greater potential, however. Already in 2002, Diers proceeded to the next development stage: the dynamic representation and analysis of the musculo-skeletal system. The sophisticated 4D technology has since offered the possibility of acquiring and documenting back and spine motion. To open up further clinical application areas in the future, a new EU research project was started in 2004 to include foot and gait analysis. During the measurement, the patient stands in an upright position about 2 meters away from the height-adjustable 3D scanner. The image acquisition time of only 40 milliseconds accommodates the fact that children, in particular, never stand absolutely still. The results are calculated and the analysis logs printed immediately afterwards.

From analogue to digital

Until recently an analogue camera and a frame grabber from the proven Falcon series of IDS Imaging Development Systems had been used for image acquisition. Meanwhile Diers has switched to a digital camera solution. The reason for the change was a need for high-resolution images for the dynamic measurements. As Diers wanted to keep development time and cost as low as possible, a smooth integration was a key factor in the selection of the digital camera. The decision was again made in favor of IDS due to its excellent software support as well as its software development kit and universal drivers. With the uEye series, the German machine vision specialist offers a complete range of digital industrial cameras designed for professional use. Their design and performance as well as their USB2.0 interface consistently meet the market requirements.

From the over 100 different cameras with CMOS or CCD sensors, USB or GigE-Inferface, with image resolutions from 640 x 480 to 5 Mpixels, with or without memory, the UI-1540-M with USB interface was selected for use in the Formetric. Besides cutting-edge features such as a high resolution (1280 x 1024 pixels SXGA), high-quality CMOS sensors with square pixels, C-mount lens connection, a universal trigger input and digital output, the IDS camera's free software development kit (SDK) that comes with every uEye was one of the primary decision making factors. The SDK significantly cuts the time required for integration with the application and provides demo programs for image acquisition and analysis, together with the corresponding source code written in C/C++. The SDK also allows control of all camera-related parameters. With its DirectDraw interface it is possible to achieve non-flicker insertion of individual information (e.g. date, time, graphics) in the live video. The SDK is identical for all uEye camera models, thus eliminating the need for reprogramming after a change of model. As it is also compatible with the Falcon series from IDS, applications based on these frame grabber boards as in Diers's case are fast and easy to adapt for use of the USB2.0 camera.

Besides the SDK, the uEye cameras provide interfaces for many popular image processing programs, such as ActivVisionTools, Common Vision Blox, Halcon or NeuroCheck. The current Windows operating systems and Linux are supported. A Twain driver, an ActiveX component and a Direct Show (WDM) driver are also shipped with the camera. Another key advantage is the camera's USB2.0 interface. Thanks to the Universal Serial Bus, the camera needs no additional hardware and allows instant connection to any modern industrial PC, laptop or embedded computer. Power supply to the camera is also via USB.



With comprehensive software support and a choice of over 60 different models, the cameras of the uEye series easily integrates with custom applications

With their design and cutting-edge features, the uEye cameras are ideally suited for professional use

Smooth Changeover

For the dynamic measurements on the treadmill, the formetric requires high-resolution cameras with a frame refresh rate of over 10 frames per second. This is easily accomplished by the UI-1540-M, with its 25 frames per second in full-frame mode and over 100 frames per second in the Area of Interest (AOI) mode. Progressive features such as binning, subsampling and image mirroring in the x and y directions complement the camera's scope of functions.

The change from analogue to digital technology required only few modifications for Diers International GmbH. The strategic decision to choose a camera that is compatible with the previously used frame grabber proved right: The changeover involved minimal development costs and short conversion times.

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A Wind of Change?

At the Automatica, INSPECT Interviewed Robot Vision Provider on Market Development

How can a robot move precisely towards objects to machine, handle, or inspect them? – By learning to see. For several years this was a domain of machine vision companies. But now a change is recognizable: More and more robot manufacturers offer their own vision systems. At the trade fair Automatica, INSPECT asked vision companies and robot producers how they interpret that development and how they see the future.

Between June 10 and June 13, 2008, 30,000 trade visitors from more than 90 countries came to Munich to this year's Automatica, the international fair for automation. About one fourth of the visitors were from abroad. At an exhibition space of 32,000 sqm (net), approx. 870 companies from 41 countries showed their latest product innovations and services in the field of assembly and handling technology, robotics and machine vision. Exhibitors as well as visitors commended the fair. "The level of visitor interest was very high." stated Jürgen Schulze-Ferebee, Director of Communication at Kuka Roboter. "Each day more and more visitors came to our stand. One very positive thing we noticed was that there was a very wide variety of sectors represented among the visitors." And the visitors got important information and contacts. According to a survey conducted by the polling firm tnt infratest 97 from 100 visitors are planning to visit the Automatica again in 2010.

Felicitous Salutation

At the entrance West of the fair halls stood a welcoming committee of a special kind: from a platform five robots from Kuka, Reis and Fanuc waved flags of participating countries. Thereby, they pointed out the fair's internationality and emphases. Robots with vision systems dominated the picture of halls B2 and B3: a robot inspected and corrected adhesive beads at Quiss, at Adept a gripper took pieces from a band and arranged them on a palette, and at HGV Vosseler robot guided sensors inspected the contours of a car body.

Robot Vision in Action

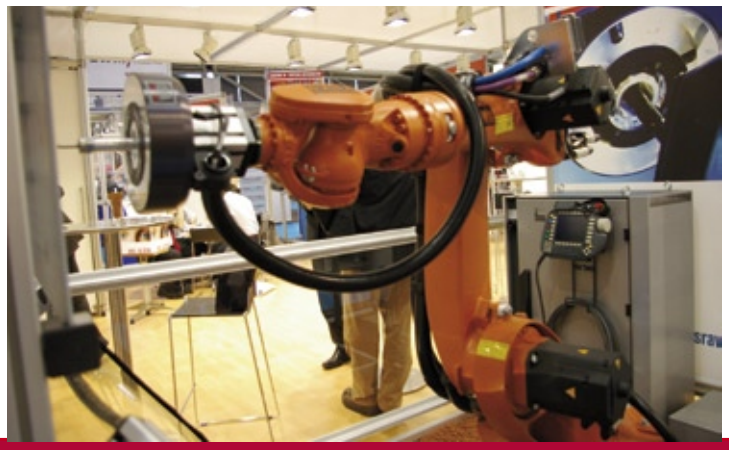
Robots with vision systems fulfill tasks out of two areas: handling and inspection. For handling tasks, the vision system has to guide the robot to the exact position of the object that should be machined or moved. 2D systems calculate the x- and y-coordinates as well as the angle of the object, while the distance to the camera stays fix. Those systems are usually applied when components are transported on a conveyor band. If not only the position of the object within the plain is interesting, but also its distance to the robot, 3D systems are used. They are mostly applied for large-sized components which can not be transported on a conveyor band, e.g. whole car bodies.

For inspection tasks, the robot acts as a transporter for the vision components. It positions the cameras so that they can inspect the designated objects. In 2D applications the objects are inspected e.g. for correct assembly or legible inscriptions. In contrast, in 3D applications the robot e.g. calculates the width and height of adhesive beads.

Now, especially for handling applications, a new trend is recognizable: robot manufacturers offer their own vision systems primarily for 2D, but some already cope with 3D handling tasks.

Robot Vision in Flux

So far, machine vision specialists were the main provider for robot vision systems. Some companies as Compar, Inos, Isra Vision, pi4_robotics, Quiss, VMT and Vitronic are specialized on it. Thus, Hoger Hofmann, Vice President at Isra Vision, affirms: "Robot vision is one of our core competences." Meanwhile, there are also amongst the robot companies many which offer their own vision sys-



Isra Vision's 3D systems is applied for seam inspection and robot guidance

Steven West: " ABB has an agreement with Braintech for the exclusive right of use for this software"

Andreas Burkart: "The loyalty and mutual support is beneficial."

Vision&Control's 2D camera sensor is specific to Schunk's gripper

Bärbel Weinert: "Vision specialists are more flexible and allow easy up-grades."

tem – either a self-developed one or one that has been engineered by a vision company.

Own Robot Eyes

Robot providers see the advantages of their own vision systems mainly in the end customer's benefit. "We produce our own robot vision systems, because they take a decision from the customer and alleviate the technical integration. Even if a customer does not know anything about vision systems, he gets a serviceable complete system," explicates Olaf Kramm, Sales Manager at Fanuc Robotics Deutschland. "Through integration of the machine vision part the whole system becomes more reliable. Quality control is incorporated in the interaction of robot and machine vision," says Rüdiger Winter from Adept Technology.

Partnerships

There are also robot manufacturers which count on a fixed cooperation with machine vision specialists. ABB, for example, offers a 2D and a 3D vision system that were developed by a partner company. Steven West, Business Development Manager from ABB, explains: „The robot controller is receiving 3D information from the eVisionFactory software. ABB has an agreement with Braintech for the exclusive right of use for this software." There are even closer collaborations: Vision specialist Vision & Control developed a camera sensor for grippers from Schunk. "We are shareholder of Vision & Control. Thus, we work particularly close with them," states Mike Mayer, Sales Manager Mechatronical Components at Schunk.

Pro and Contra

With own vision systems, robot manufactures do not only want to alleviate the purchase and use of robots, but also speed up the processes. Jens Voss from Seika Sangyo points out: "The customer receives a complete system out of one hand. Because the systems are adjusted on and linked to each other, a fast communication between vision and robot is guaranteed." Particularly adapted interfaces and with them better integration of the vision components are considered as beneficial. Peter Pühringer, Key Account Manager of Stäubli Tec Systems, states: "We cooperate with long-term vision partners. Adaptations to their interfaces are profitable for us as well as for our end customers."

Staying Open

Because of the commitment to one partner or system, a manufacturer is less flexible on special customer requests. That's why most of the robot manufacturers still provide open interfaces. A number of the bigger robot producers oppose to own vision systems. Willibald Hartig, Sales Manager at Reis Robotics, reports: "Several years ago, we offered an own vision system. We recognized that it was not profitable, because the customer requests were extremely complex and variable. Today, there are specialists, who supply us with a vision system according to the requirements of the customers."

Partner or Competitor

How do vision companies experience the vision trend of the robot manufacturers? Bärbel Weinert, responsible for Marketing and PR at Vitronic, looks calmly at it: "Everybody has his niche, his strengths and weaknesses. The usage always depends on the application and the requirements of the end customer. Vision specialists are more flexible and allow easy up-grades." Mahmoud Chatah, Key Account Manager at Inos, confirms this point: "The high measurement accuracies for 3D applications, the position tolerances and the unknown ambied light are tasks which can be better solved by vision specialists than robot manufacturers." Andreas Burkart, Marketing Manager at Compar, sees chances precisely in partnerships: "The loyalty and mutual support is beneficial." Hans-Günter Vosseler, President of HGV Vosseler, differentiates his evaluation of the trend: "Robot manufacturers have simple solutions. In contrast, we offer 3D measuring technique for robots. But vision providers who are specialized on sensors could be noticeable affected by that development."

What Does the Future Bring?

Today, the development of the robot vision market is open: Can robot manufacturers do without vision companies in 2D handling applications? Will vision providers concentrate on inspection and 3D tasks? Which role will the system integrators play? The next Automatica might give some answers to these questions.

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glasstec 2008

International Trade Fair covering the entire Value Chain for Glass with all its Facets

glasstec 2008 – the course is charted. From 21 to 25 October 2008 the global glass industry will convene in Düsseldorf for the 20th time now to present the latest developments in the field. Be it glass producers, glass machinery manufacturers or the glazier trade – glasstec is the only international trade fair covering the entire value chain for glass with all its facets.

"Glass and energy" will be high on the agenda at the forthcoming glasstec. Worldwide reductions in CO_2 emissions and careful use of oil and gas resources are as pertinent issues as ever. And the demand for new, energy-efficient glass products and manufacturing technologies is correspondingly high. Companies from throughout the world are currently working 'flat out' on the development, optimisation and supply of the relevant products, their applications and the associated manufacturing technologies. Many solutions for "energy-efficient products and production" will be showcased at glasstec 2008. However, such "classic" subjects as laser technology, functional coatings, nano-technology, industrial glass and special glass will also leave a lasting mark on glasstec 2008. Innovative potential will be equally high in these sectors once the development of new applications and manufacturing processes for glass come into play.

At the latest glasstec in October 2006 more than 1,250 companies, associations and research institutes from 46 countries were presented. Over 54,000 trade visitors from throughout the world gathered information at the Düsseldorf exhibition halls. 98% of these visitors rated the trade fair as very positive, voicing their satisfaction with the visit. No other glass trade fair in the world can pride itself on such high approval and acceptance levels.

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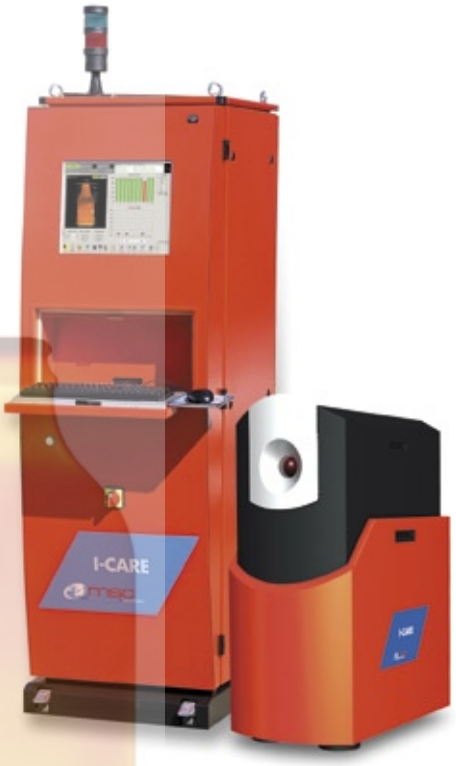
MSC, SGCC & Visiglas

glasstec 2008 Exhibition Preview

Formed at the beginning of 2008, the Tiama group with MSC, SGCC and Visiglas as their hollow glass industry business group aims to provide the best quality machines in the glass industry based on second to none R&D, "Red Carpet" Service with worldwide 24/7 and worldwide presence for the glassmakers.

To stay always ahead, MSC, SGCC & Visiglas provide a wide range of products for hollow glass inspection and cosmetic & pharmaceutical glass. The global solution for glassmakers equips the whole production line: the Hot-End & the Cold-End.



Hot-end Inspection Solutions

- Laser Hot End engraving system for containers traceability during all the production process and during the whole glass container life thanks to a unique code
- I-Care: hot end device for production trends and stability analysis, critical defect recognition and process optimization (consistent operator-oriented tools)

Cold-end Inspection Solutions

- ICAM & MCAL: Powerful vision machines for sidewall, dimensional and stress inspection
- Multi: Base vision and base stress inspection with enhanced functionalities, an extended finish inspection including wide mouth jars, and dot digital codes mould number reader by camera
- Combi: An equipment that combines sidewall and base vision detections
- Quick, Check +: Servo motorized multi inspection with optical plug gauging, leakage and tightness, non-contact wall thickness, non-contact ovalization on the widest range of containers
- Atlas: Check detection by cameras

Cosmetic & Pharmaceutical solutions

- Astra: detection device for cosmetic defects in the sidewalls and dimensional control for perfume, nail polish bottles and drinking glasses
- Argos: Online check detection and inspection on a wide range of containers

Supervising system

- IAFIS system: plant supervising system for real time date

Laboratory devices

- Laboratory devices such as Seedlab (device counting and categorizing seeds to measure the glass refining mark), profiler and others

With their combined know-how MSC & SGCC and Visiglas offer a wide range of innovative and high-performance inspection devices shown at glasstec, booth 13C89.

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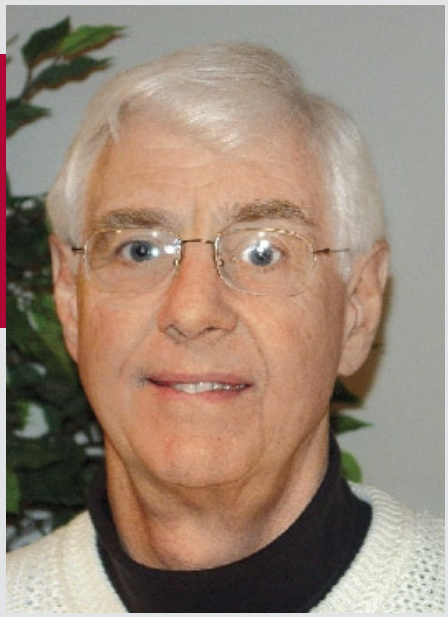
North American Vision Market Intelligence

A glimpse into the US economy by Nello Zuech

Of the eight economic indicators reflecting potential economic activity related to machine vision and tracked in the quarterly survey of industry expert Nello Zuech, based on moving averages six are flat or trending negatively.

So what does this mean for machine vision? Unfortunately, going into the third quarter of 2008 virtually all the economic trends related to capital spending in US manufacturing industries are either flat or trending negatively. Hence, spending for machine vision in the US manufacturing industries is also likely to trend negatively. Currently we expect the North American machine vision market to decline 4–6 %, although an uptick in spending for machine vision in the second half is possible, which would offset the steeper declines anticipated in the first half. Our current thoughts on the world market are still positive, so most US-based machine vision companies are unlikely to experience a decline in their worldwide revenues from machine vision sales. In general, they will not see a significant increase in overall revenues because their US sales will be off.



In other words, most US-based machine vision companies will likely see sales remain flat.

In a recent survey by Deloitte, Made in North America, North America – especially the United States – was cited as the most likely location for expansion in the short term. However, more than half of survey respondents (61 %) said they expect North America to become even less competitive globally as a site for production by 2012. The key barriers to making production competitive globally were seen as labor cost, tax policy, work rules, lack of availability of skilled labor and costs of raw materials and energy. This does not bode well for the future of machine vision in North America.

Since 1983 Vision Systems International (VSI) has been an independent and impartial engineering and marketing consultancy specializing in machine vision and inspection automation technologies. VSI publishes a quarterly Machine Vision Newsletter designed to support the management of companies in the machine vision industry to better understand the machine vision market with the objective of assisting them to grow their business by alerting them to business trends and potentially new opportunities. The annual subscription price is $ 500.

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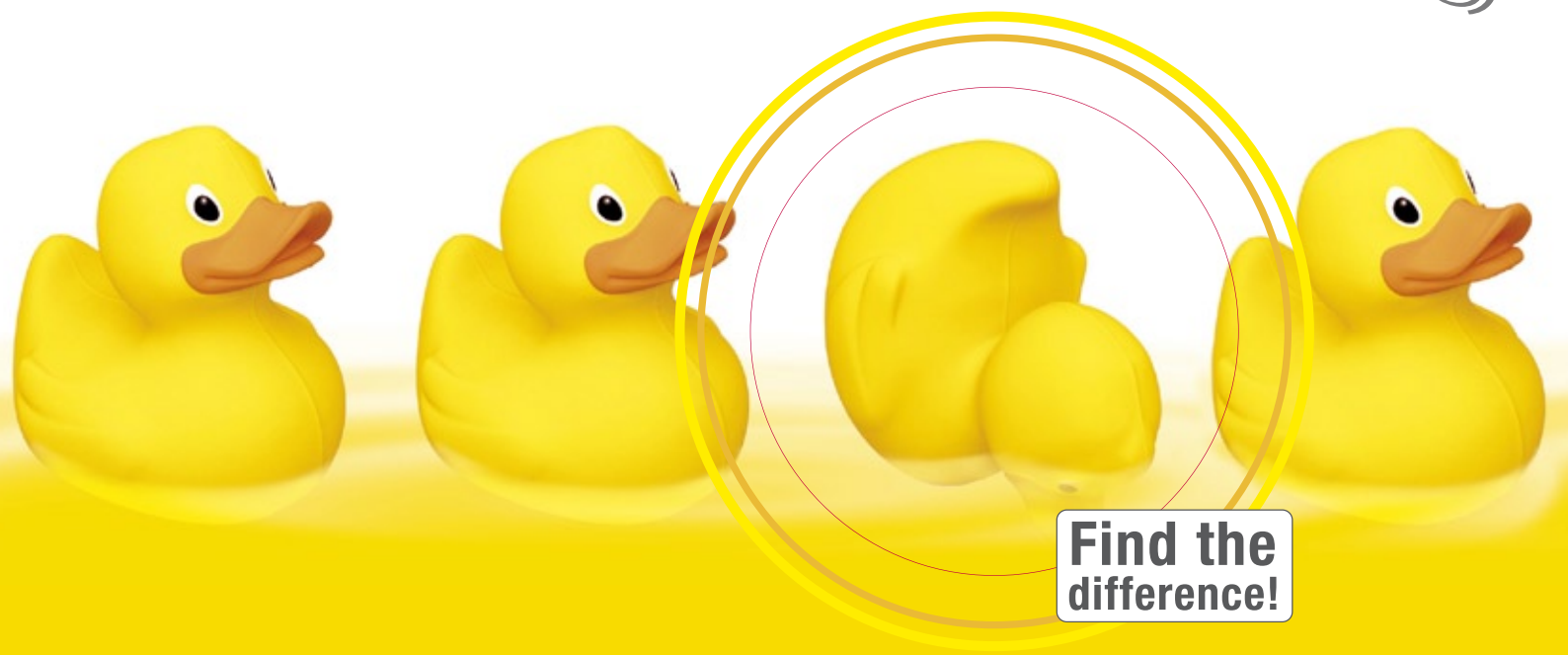

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www.vision-messe.de

Get It Straight

Image Processing Basics: Hough-transform

The Hough-transform is best known as a method "to find straight lines" in an image. Unfortunately, people who encounter the concept for the first time usually are somewhat irritated by the mathematical formalities necessary to get it straight. The basic idea of the Hough-transform, however, is simple. The simplicity, the elegance and the potential of the method immediately becomes clear when looking at the Hough-transform for circles rather than for straight lines. Once you have caught the wave, you will easily follow the arguments leading to the detection of other analytic curves, including, of course, straight lines – and you will immediately understand the main advantages of Hough-transform, namely, to detect partly occluded shapes and incomplete curves.

The Basic Idea

Imagine a simple binary image like in the left part of figure 1, containing a single, complete circle of black pixels on a white background. Let us first try to find the center of this circle, and let us assume that the radius of the circle is already known. A circle is the set of points which have the same distance to a common point, the distance being the radius and the common point being the center of the circle. To find the center of the circle, you may proceed as follows: for every pixel of the image, beginning at the upper left corner and scanning the image along its lines and columns like with a filter-operation, draw a test-circle with the desired radius around the pixel. Then check the amount of overlap between the test-circle and the "real" circle in the image: walk along the curve of the test-circle, check for black pixels on this circle, simply count the number of these black pixels and store this number in a new image at the current center of the test-circle. For many positions of the test-circle there will be no overlap at all, and the resulting number will be zero; some positions will yield an overlap in one or two pixels, resulting in the numbers one and two; but once you hit the center of the real circle in the image, the result will be the greatest possible number which can be achieved by this procedure. The numbers stored at the pixels of the resulting image may be interpreted as grey-levels, and the center of the circle can easily be identified as a bright spot on a dark background.

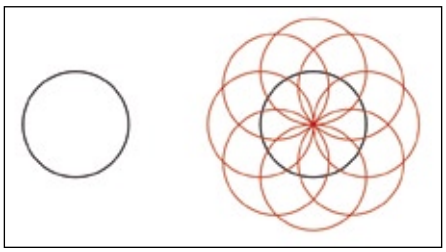
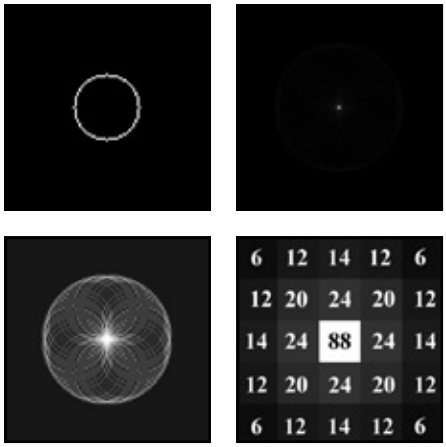


Fig. 1: A circle and some circles with the same radius drawn around points on the boundary

This approach yields good results, but it is not very effective. In many applications, large areas of the background will be examined, although the black pixels of the real circle are far away. Obviously, it would be much better to somehow use the foreground-pixels for guidance instead of scanning the whole image. But how? Now it is time for a great leap: let us put the method upside-

down (or rather inside-out). Instead of drawing a circle around every pixel, foreground or not, and checking for black pixels on the curve, let us draw circles with the desired radius around the black foreground-pixels only and take a look at the resulting image, containing the real circle and all the circles drawn around the pixels on its curve. Some of these latter circles are shown in the right part of figure 1, highlighted by the red colour. All these circles have one common point: the center of the real circle, where they all coincide, and the number of coincidences is equal to the number of pixels on the curve of the real circle. Thus, the number of coincidences is the same number you will get when drawing a circle with the desired radius around the center of the real circle and counting the number of black pixels on the curve of this test-circle, like in the procedure explained before – but much more effective! Think about it for a few seconds, and you will see that the two methods are equivalent, they will yield the same result. Counting the coincidences is very simple: allocate a new image and initialize all grey-levels to zero; go to the position of a black pixel in the original image, draw a circle with the desired radius around this position in the new image, and add 1 to the grey-level of every pixel you touch by drawing this circle in the (new) resulting image; do so for every black pixel in the original image. By this procedure, you will accumulate the coincidences in every pixel, the number of coincidences being represented by the grey-level in the new image, the so-called accumulator-array. Finally look for the brightest spot in the accumulator-array: this is the center of the circle. If the radius chosen is wrong, there will be some coincidences as well, but not as many as with the proper radius. Thus, in the accumulator-array, the centers of the real circles in the image will pop-up as spikes on a noise-floor. This is the basic principle of the Hough-transform.

Now let us skip the assumption that the radius of the circle is already known. In this situation it takes a bit longer to find the position of the circle (and its radius), but just guess and try! Choose a reasonable interval for the radii of the test-circle and proceed as before: for every radius chosen, scan the image for overlap between the test-circle and the real circle. The result will be not a single image, but one image for every radius of the test-circle, a whole stack of images. But, as with the situation where the radius is already known, there is exactly one image out of the stack with the brightest spot (that is, the highest number of overlap) of all spots of all images in the whole stack, the center of the real circle corresponding to the position of the brightest spot and the radius of the real circle corresponding to the radius of the test-circle used for this particular resulting image. Even if you just add up the whole stack of resulting images to a single image, simply adding the grey-levels of corresponding pixels in the stack of resulting images to a single accumulator-image, there will usually remain a



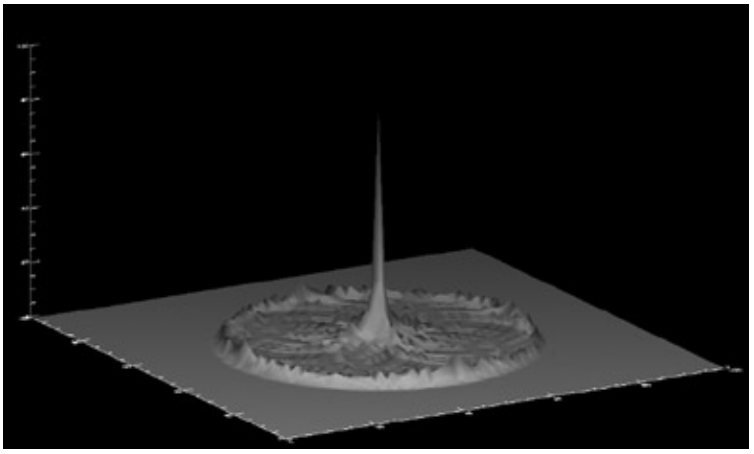


Fig. 2: Hough-transform for a circle a) binary circle in the discrete image plane; b) accumulator-image resulting from Hough-transform; c) accumulator-image, contrast-enhanced; d) central area of the accumulator with grey-levels as insets; e) 3D-plot of the grey-levels of the accumulator

bright spot at the center of the real circle.

A Simple Example

Figure 2 shows the procedure with a synthetic circular structure in a binary image. The pixel-structure due to the discrete image-plain is clearly visible. The corresponding accumulator-image is quite similar to the sketch on the right side of figure 1, showing a prominent spot at the position of the center of the circle. Further structure can be found in the accumulator-image, namely a second circle with a greater radius and some ripple in the background. Figure 2 also shows a contrast-enhanced version of the accumulator-image to amplify these structures. It is easily seen from figure 1 how these features arise. To get a better idea of the numbers, the innermost 5 x 5 pixels of the accumulator are shown in an enlarged view, with their grey-levels as inserts. Finally, a 3D-plot of the grey-levels over the coordinates of the accumulator gives an intuitive view of the signal-to-noise-ratio.

A similar situation may appear in real-world-images like in figure 3. To take advantage of the Hough-transform, it is a good idea to isolate the boundary of objects, yielding best results with boundaries thinned to a width of a single pixel. This has been done in the second image in figure 3. The Hough-transform is then applied to this pre-processed image, resulting in a bright spot in the accumulator at the center of the wheel.

Advantages

It is immediately clear that this method may consume a lot of computing power, but it has some very important advantages. It works not only for a single complete circle, but also for circles where parts of the curve are missing, either as a whole sector or in the form of several small gaps in the curve like in a punctuated circle. The overlap-number, however, will become lower than with full circles, and the discrimination between the brightest spot in the accumulator-image and the background will become less robust and eventually break down once the number of pixels defining the circle becomes too small. Another advantage: it is not necessary that the circles under examination are separated from each other like in blob-analysis; two or more circles may be overlapping and will nevertheless usually be detected.

Figure 4 shows an example for overlapping circles, which already appear as well-prepared boundaries in the original image. Again, a second, post-processed version of the Hough-image is shown to enhance the additional structure in the accumulator. The example in figure 5 shows several coins, most of these objects being clearly separated from each other, but two coins are just touching each other and three others are overlapping, which appear as connected and partly occluded circular objects in the image. Isolating the boundaries and performing the Hough-transform yields the centers of all theses circles as clearly visible bright spots in the accumulator.

There are numerous other examples to show the potential of the method. There may arise some disturbing features, however, in uncontrolled scenes, such as in a search for traffic-signs in a street, and computing the Hough-transform for certain images may well take several seconds even on a state-of-the-art personal computer.

Hough-Transform for Straight Lines

While the basic idea of the Hough-transform for circles and the construction of the accumulator can be intuitively understood and even be implemented straight-forward, the Hough-transform for straight lines needs some mathematical considerations. As with the search for circles, it is not necessary to have complete straight lines in the image. The Hough-transform rather looks

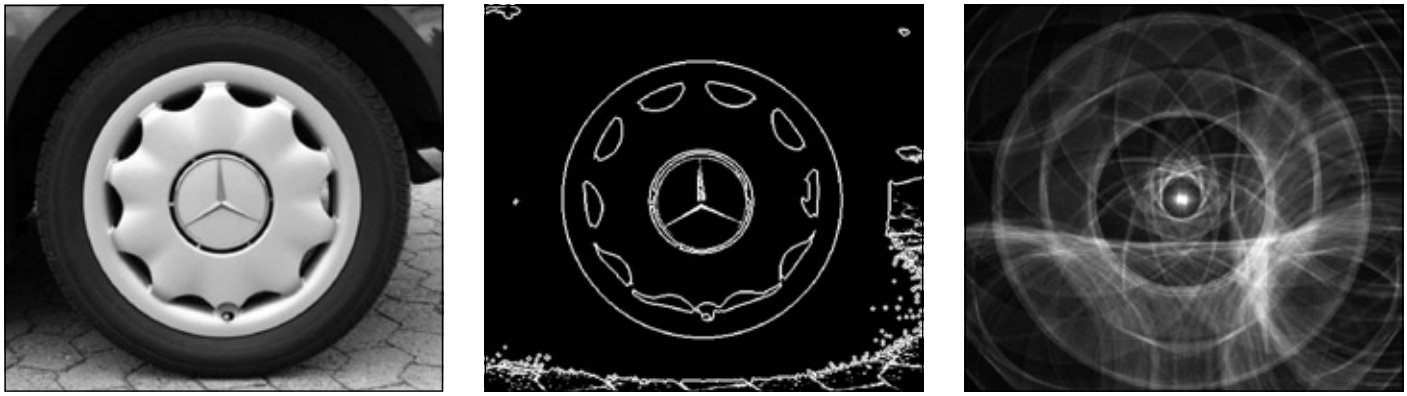


Fig. 3: a) original image; b) boundaries have been isolated and thinned; c) contrast-enhanced version of the accumulator after Hough-transform applied to the boundaries

for the set of pixels in an image which are collinear, that is which are located on a common straight line which may be drawn through these pixels. As with the search for circles, we might draw all possible straight lines through all pixels in the image and count the black foreground-pixels on these lines, thereby getting a figure of merit for discrimination of the desired line. Obviously, this is quite a task. Again, a much better starting-point are the black pixels in the foreground. First imagine that something is already known about the straight line we are looking for, its slope, for instance. Then we might draw a straight line with this slope through every black pixel in the foreground, getting a number of parallel lines. When two or more pixels are collinear, their corresponding straight lines will coincide, the number of coincidences being identical to the number of pixels on this particular line. Unfortunately, with a straight-forward-approach it seems to be quite complicated to check for coincidences between whole lines in an image. But when we look at the well-known representation of a straight line in the xy-plane in the slope-intercept-form, y=mx+b, it becomes clear that out of all the parallel lines with the same slope m those straight lines are identical which have the same intercept b. To check for coincidences between two lines with identical slope m, we thus simply have to calculate their intercepts b_1 and b_2 and compare. For a given point (x,y) on a straight line with slope m, the intercept will be b=y-mx. We may thus proceed as follows: allocate an accumulator-vector with one element for every possible value of b and initialize to zero; go to the position of a black pixel in the original image, draw a straight line with the desired slope m through this pixel and calculate the intercept b; add 1 to the value of the corresponding position in the accumulator; do so for every black pixel in the original image. By this procedure, we will accumulate the coincidences between straight lines through every pixel, the number of coincidences being represented by the values in the accumulator. Finally look for the brightest spot in the accumulator: this is the intercept for the common straight line.

When neither intercept nor slope is known, we can generalize the approach. For every black pixel, there is a whole bundle of straight lines with different slopes and different intercepts which can be drawn through this pixel. Slope and intercept, however, are not arbitrary; there is the relation b=y-mx between b and m for all the straight lines which contain a single pixel (x,y). If we plot the possible values for b and m for a given, fixed pixel (x_1,y_1) in a diagram spanned by m and b, the mb-plane, we will get a straight line, characterized by the equation $b=-x_1m+y_1$, $-x_1$ being the slope and y_1 being the intercept of the line in mb-space. A single pixel (x_1,y_1) is thus transformed to a whole straight line in mb-space. A second single pixel (x_2,y_2) will be represented by a different straight line in mb-space. These two lines in mb-space will intersect at a single point with common values for m and b, thus completely characterizing the straight line in xy-space connecting the two pixels (x_1,y_1) and (x_2,y_2). Obviously,

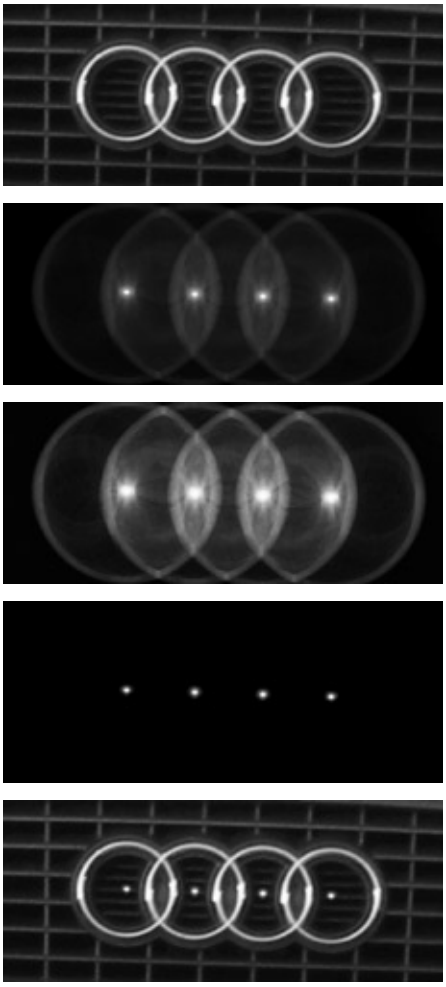


Fig. 4: Hough-transform for overlapping rings a) original image; b) and c) accumulator-images after Hough-transform, raw-image and contrast-enhanced; d) accumulator after thresholding; e) overlay of a) and d) showing the centers of the rings as bright spots

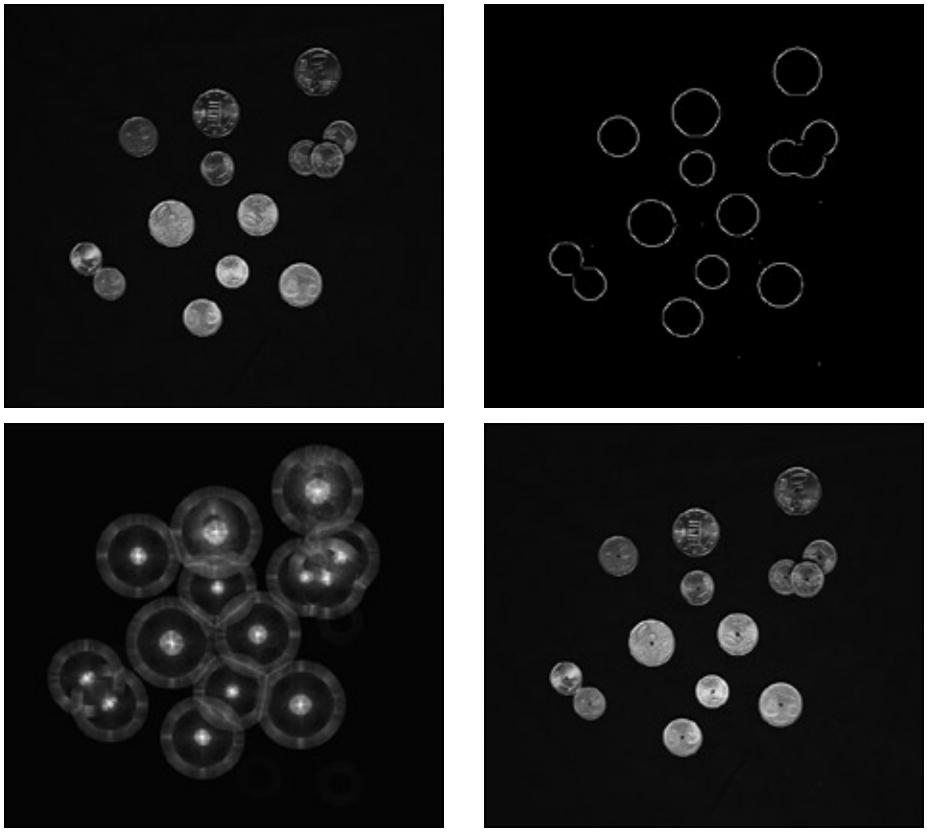


Fig. 5: Hough-transform for partly occluded coins
a) original image; b) boundaries have been isolated and thinned; c) accumulator-image after Hough-transform, contrast-enhanced; d) the original image, showing the result of thresholding of the accumulator as black spots in the centers of the coins

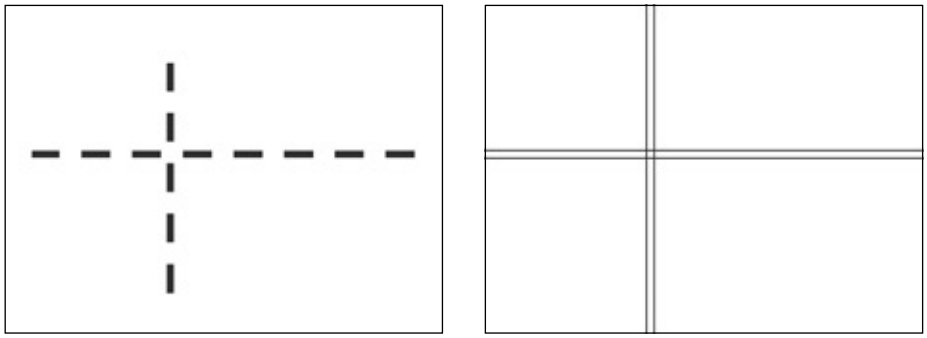


Fig. 6: Hough-transform for straight lines
a) original image; b) straight lines detected with Hough-transform, applied to boundaries

mb-space is an accumulator-array which allows to simply add-up all coincidences between straight lines which appear when drawing the bundles of possible straight lines through all the foreground-pixels in the image. For every black pixel (x,y) in the image, we simply have to draw the corresponding straight line in mb-space; whenever we hit a certain combination (m,b), we add 1 to the corresponding pixel in the accumulator-image. Finally, the brightest spot in the accumulator-image represents the slope m and the intercept b of the desired straight line, and we may go back to the original image and draw this line.

In practice, the Hough-transform for straight lines is not implemented with the parameters slope and intercept, but with the orientation and the distance from the origin according to the normal or Hesse-representation. In this parameter space, a point transforms to a sinusoid rather than to a straight line. Collinearity, however, is again detected by the intersection of these curves in parameter space. The implementation of the Hough-transform for straight lines is not simple, and it is a good idea to consult some standard textbooks [1] [2] to tackle the various further aspects which are far beyond the intentions of this introductory article. Figure 6 shows a simple example for the detection of straight lines in a binary image, omitting the various steps of analyzing the accumulator and just giving the resulting lines in the xy-plane.

Further generalization

The basic idea of the Hough-transform is the construction of an accumulator in a parameter-space. Straight lines are characterized by two parameters, resulting in a two-dimensional parameter space. Other geometric forms such as elliptical curves may be described analytically by more than two parameters. The accumulator-space will thus become more complex and the computing-power necessary to reasonably implement such a method may be beyond current technology, but the concept remains the same. Hough proposed his approach in 1962 [1], probably not even dreaming of the performance of current processors. About 20 years later, in 1981, Ballard [3] published a method for Hough-transform of arbitrary non-analytic shapes. Nowadays, we can get tremendous computational power at reasonable cost, and the Hough-transform for straight lines and circles may well be performed at video-frame-rates in certain applications. The literature is full of such clever, sophisticated algorithms from the 60s, 70s and 80s of the last century, waiting for us to be re-discovered and longing to be implemented on our powerful processing systems.

Acknowledgements

Thanks to diploma-student Sven Schneider for preparation of the images for the Hough-transform for circles, and thanks to my colleague Stephan Neser for pointing out the relevance of reference [3].

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INSPECT

Vision

VISION: COMPONENTS AND TECHNOLOGIES

The Vision section of INSPECT deals with new trends in the camera market, changes in frame-grabbers, the wide range of lenses, the rapidly increasing variety of illumination as well as with the increasing use of smart cameras, vision sensors and compact systems. Software, with its facets of algorithms and user guidance as well as data processing and communication, has its platform in the Vision section. In addition, the „hidden heroes“ such as interfaces, processors and cables are taken out of the shadow and their effect on the success of the equipment as a whole is given appropriate editorial attention.

The Vision section is addressed both to readers who plan the in-depth technical details of systems, as well as to users for whom Plug, Play & Forget is the primary aim.

Meet me in the Holodeck

Augmented Reality System Using Firefly MV Blends Real World and Virtual Space

Every Star Trek fan has wondered what it would be like to use the "holodeck", a room where real people would interact with simulated characters and environments. Augmented reality (AR), a field of computer vision research that involves combining real-world people and environments with computer-generated content, brings this idea to life.

Unlike virtual reality (VR), where the environment that an individual interacts with is completely computer-generated, AR technology superimposes perspectively-correct 3-dimensional graphics onto real-time video feeds. Designed to augment – not replace – reality by enhancing the user's senses with synthetic information, an AR environment is typically defined by three key characteristics: it combines real and virtual elements; it is interactive in real-time; and it is registered in three dimensions (3D).

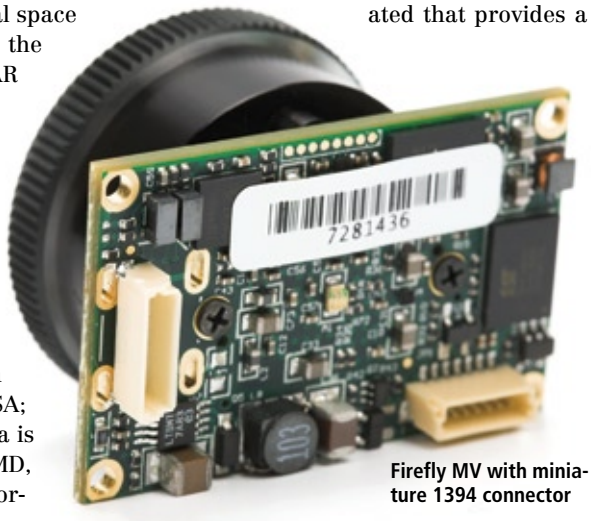
AR applications are as varied as the realities they augment. Most of us have likely seen augmented reality in use in our daily lives, without even knowing it. Live sports, for example, can be enhanced with graphics identifying the drivers in a NASCAR race, or a yellow "first down" line in a televised football game. Other applications are built to maximize the operation and efficiency of certain tasks. For instance, using a system like the Microvision Nomad, truck and automobile diagnostics and instructions can be overlaid directly on a technician's vision via a head-mounted display (HMD) for more efficient vehicle maintenance and repair. And X-ray vision surgery, like that developed by scientists at the Fraunhofer Institute, is made possible by AR. A surgical operation plan can be projected onto a patient's body, allowing the surgeon to "see" like an X-ray where nerves and blood vessels are situated.

Cameras for Second Life

Augmented reality applications in entertainment and gaming are also growing. Researchers at the Georgia Institute of Technology's GVU Center (Atlanta, GA, USA; www.gvu.gatech.edu) have developed AR Second Life, the first augmented reality interface to a massively multiplayer online (MMO) world. MMO's are persistent virtual environments where people play, experiment and socially interact. Based on the 3D virtual world Second Life, it blends together locations in physical space with corresponding places in the Second Life virtual space and leverages the power of the MMO to create a powerful AR authoring environment targeted at a wide audience and range of applications.

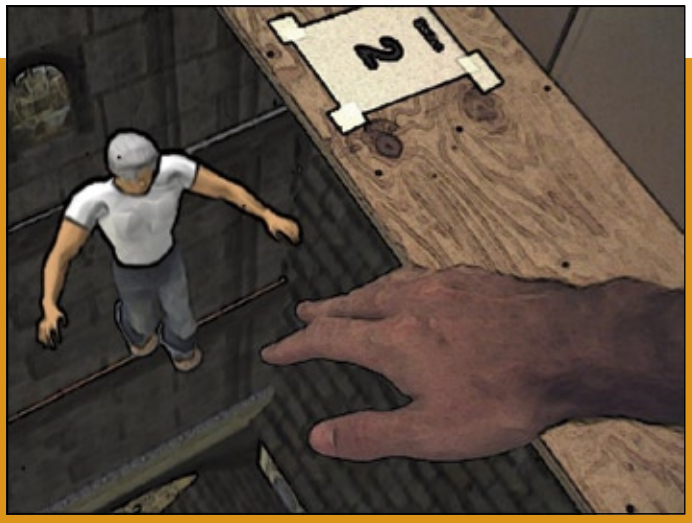
For their head-mounted display (HMD) client, AR Second Life uses a wide-VGA Firefly MV IEEE-1394 400Mbit/s digital camera from Point Grey Research integrated into a Z800 HMD from eMagin (Bellevue, WA, USA; www.emagin.com). The camera is mounted on the front of the HMD, pointing down and reflected forward using a right-angled prism. This orientation allows the camera to be optically closer to the person's eyes than would otherwise be possible, which further enhances the feeling of reality. An IS-1200 hybrid tracking device from Intersense (Bedford, MA, USA; www.intersense.com) is used to track the exact position and orientation of the HMD precisely over a large area.

The Firefly MV is connected to a MacBook Pro from Apple, running Windows XP. Power and data are sent over a single IEEE-1394 cable via the MacBook's powered 6-pin FireWire port. Image acquisition and camera control is performed by VideoWrapper, an open source C/C++ library they created that provides a

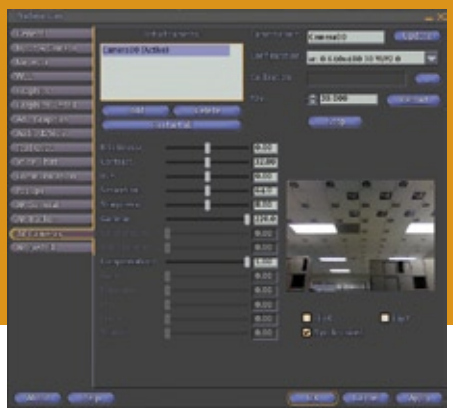


Firefly MV with miniature 1394 connector

Tiny 29x40mm Firefly MV IEEE-1394 digital camera



The AR Pit developed using the AR Second Life client



AR Second Life camera control interface

single abstract API for interfacing to a variety of video camera libraries on Windows and Mac OS X, including Point Grey's FlyCapture SDK. The Firefly MV, which uses a CMOS sensor with global shutter, is used to capture 640x480 raw Bayer (color) images at 60 FPS. The AR Second Life client software is written in C++. It processes in real-time the images from the Firefly MV and the head location data provided by the IS-200 head tracker, and generates 3D graphics that are overlaid on the scene. The final result is presented to the user via the Z800 HMD. The AR Second Life client also provides a full graphical user interface (GUI) that allows the user to control camera parameters such as exposure, brightness, frame rate and resolution.

"We have used Firefly's, Flea's and Dragonfly's from Point Grey in our work, and had been using Flea's and the extended-head form factor of the Dragonfly for our previous head-worn displays," explains Blair MacIntyre, Associate Professor in Georgia Tech's School of Interactive Computing and GVU researcher. "We are now working with the current generation Firefly MV, which provides a nice balance between size, image quality and frame rate, at a much lower price point. It also supports automatic inter-camera image synchronization, which is important for creating stereo displays where the left and right eyes need to be synchronized."

Avatar Presence for Real

AR Playspace and The AR Pit are examples of applications built using the AR Second Life client. The AR Playspace experience is a public mixed-reality performance space where visitors in both the real and virtual domains can enter the mixed reality space and see the "other side." People in the physical space are filmed with a video camera and can see themselves on a large video screen that shows the augmented output. As soon as a virtual avatar enters the matching space in Second Life, they appear in the augmentation. In order to give the avatar a view of the physical world, the augmented output is streamed as a video back into Second Life. Both spaces are blended together and actions in either domains are perceivable in the other space. Voice-over-IP (VoIP) support even allows real-time audio transmission between both spaces.

The AR Pit experiment is a demonstration about the rapid prototyping capabilities of AR Second Life. The experiment is based upon an attempt to objectively measure the effects of "presence", which is the subjective feeling of "being there", in Augmented Reality applications. The more presence a participant of an AR experience feels, the more convincing the augmentation (such as a fall from a high place), up to the point were the user forgets about the artificial nature of the scene. The AR Pit attempts to measure presence while adjusting parameters such as quality of the 3D graphics and responsiveness of the tracking.

"Many companies are exploring how to leverage multi-user online virtual worlds like Second Life for a wide range of applications," explains MacIntyre. "While our current work is focused on machinima and digital performance projects, our work on integrating AR techniques with these virtual worlds will allow us and others to explore solutions to many business challenges, such as collaboration of distributed teams, entertainment and education, and even manufacturing."

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How Robot Companions See the World

Methods to Equip Robot Companions with Sophisticated Vision Abilities

Developing cognitive robots whose "purpose in life" would be to serve humans as assistants or "companions" is part of the of the European Commission's 'Beyond Robotics' workprogramme. Such robots would be able to learn new skills and tasks in an active open-ended way and to grow in constant interaction and co-operation with humans. What we've seen for decades now in the movies, growing ever more skillful and more beautiful, might finally come true. Some of these companions were shown at the Automatica trade show in Munich this year and sported remarkable vision abilities.

Beyond applications in the classical industrial machine vision domain, many international research institutes are actively working on methods and algorithms to equip new robot companions with sophisticated vision abilities. The idea of a robot companion can be described by a collection of their components and technologies:

- A mobile platform with localization and path planning capabilities to enable the robot to move to a specified goal without bumping into obstacles
- A manipulator arm attached to the robot to apply physical actions to the environment. This includes the direct manipulation of objects, e.g. in order to serve food or drinks to a user or accessing operations such as opening doors or draws
- A sensor system including cameras to observe the environment and adapt actions according to changes
- A multi-modal human-robot interaction system including speech dialogue enabling the user to pass commands in a natural and intuitive way
- An overall control system that coordinates the actions and sub-actions to be performed in order to execute a task

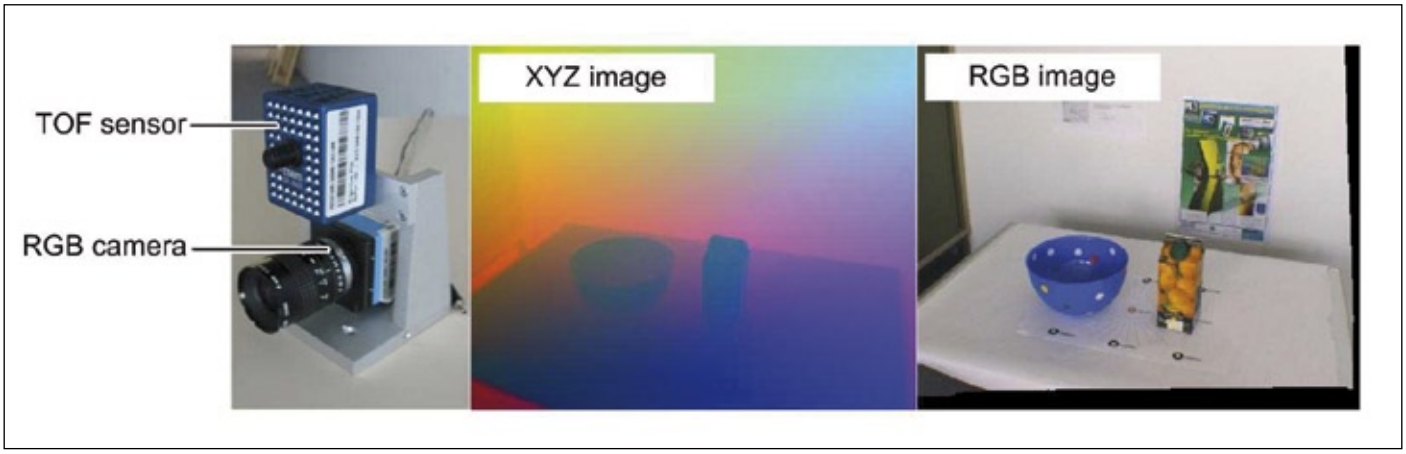
Robot companion research platform "Care-O-bot 3"

As a first step into the realisation of such a robot companion Fraunhofer IPA introduced a hardware technology platform called Care-O-bot 3 (www.care-o-bot.de) at the Automatica 2008 trade show.

Vision sensors and algorithms are essential for dependable robot behaviour in the real, mostly unknown, world. This is due to the fact that the environment is not static, as it is the case for industrial robotic cells, but underlies a significant degree of variation and unpredictability. Vision sensors can capture a large part of the environmental state quickly with one image frame already.

Time-of-flight Range Imaging Sensors

In addition to conventional CCD or CMOS colour imaging cameras so called time-of-flight (TOF) range imaging sensors are increasingly used in modern robotics. These modern products (www.mesa-imaging.ch, www.canesta.com, www.pmdtec.com) deliver images similarly to colour cameras, the difference being that each pixel contains the distance value instead of RGB values from which the coordinates XYZ can be computed. By combining a range imaging sensor with a colour camera it is possible to upgrade 2D recognition algorithms that are usually applied in traditional grey- and colour-image processing systems to 3D recognition algorithms. To achieve this, a special calibration between the two sensors is used in order to compute a modified colour image, the pixel coordinate system of which is aligned with that of the range image. This means that not



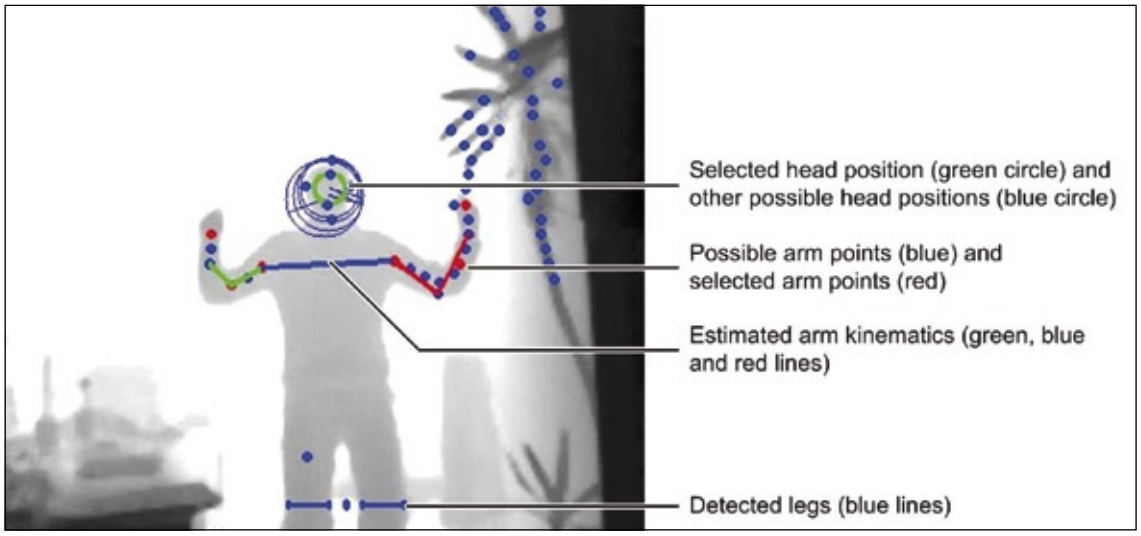
A TOF range imaging sensor SR3100 (Mesa Imaging AG) and a conventional CCD RGB camera are used as one unified colour and position sensor system

only the colour value, but also the distance of the corresponding location is known for each pixel in the image.

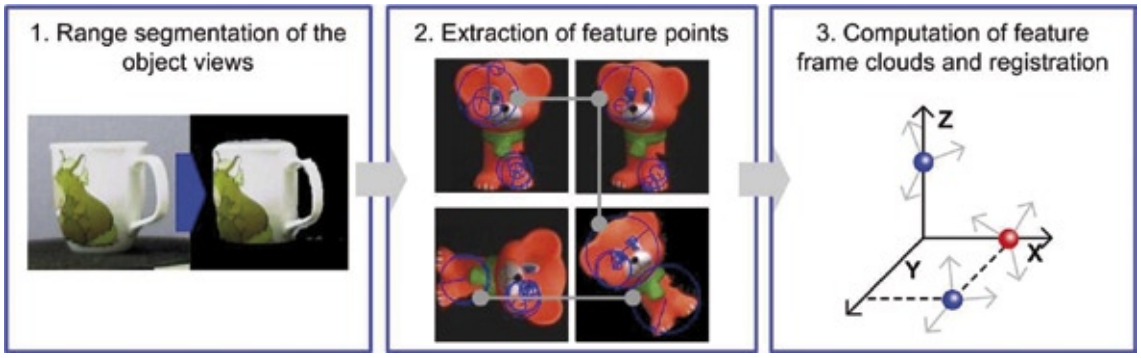
The calibration process required to align both images is based on a perspective transformation from the coordinates delivered by the range imaging sensor into the image plane of the RGB camera.

Fast Scale Invariant Feature Points in 3D

Besides new developments on the hardware side of vision, a large number of new image processing algorithms is investigated in the service robotics community. The Scale Invariant Feature Transform (SIFT) originally proposed in [1] has widely been adopted in robotics. The strength of these feature points is that stable structures in the image are detected even if occurring at various sizes. Attached to each feature point are an image position, a scale (size) measure, a gradient direction, and a high di-



Visualisation of the results of the human detection algorithm



The basic steps of the model construction procedure. Left: range segmentation of one object view, centre: detection of feature points (blue circles), repeating points are connected by grey lines, right: simplified depiction of a 6D feature point cloud

mensional descriptor vector that contains detailed regional information. The descriptor vector can be used to match corresponding points in two images or between a data base and an image (e.g. for object detection).

Inspired by previous work on speeding up feature point detection [2] a new feature point detection algorithm has been developed at Fraunhofer IPA. It uses a box (mean) filter that can be efficiently computed and a novel fast recursive search strategy. The resulting feature points are blob-like and edge structures with high contrast that can be found faster than the original SIFT points. However, this can only be done at the cost of matching accuracy due to the use of the box filter.

An interesting new idea is to compute these feature points in the Z distance layer of the XYZ image. Assuming a constant linear relationship between the scale of a feature point and its real distance to the sensor, structures of fixed size can be detected. At Fraunhofer IPA this method is used to realize a head detector embedded in a more complex human detection algorithm that proceeds through the following stages:

1. Detection of the human legs in the range image by a line scan and minimal search
2. Detection of the human head based on the new fast feature points
3. Detection of possible arm points similar to the leg detection
4. Estimation of the arm kinematics through an iterative fitting process

The leg and head detection can be computed in less than 80 ms. The fitting process takes about 500 ms and the precision of the detection is about 2 cm. Faster rates are possible by reducing the image size which in turn reduces the precision. The algorithm can be used e.g. to estimate the pointing direction of a human interacting with the robot.

Learning 6D Single Object Detector

For the autonomous execution of handling tasks in variable everyday environments, a robot companion must be capable of detecting objects in 3D space and computing their precise position and orientation. Position and orientation can be described by a 6D vector that contains three translation components and three orientation components (e.g. Euler angles).

The 6D detection of an object must be fast to compute and robust against changes in the environmental conditions such as altering light. As in typical application environments of the robot compan-

ions objects are subject to frequent changes, the robot must be able to automatically construct models of new objects from data acquired in the real world.

In order to achieve this learning capacity the new feature points are computed from the Z layer of the XYZ image and from all three colour layers of the RGB image. For each feature point a local coordinate frame is estimated on the basis of the feature point's orientation and the local surface normal that can be computed from the XYZ image. The descriptor of the feature point is used to compute a stable key. The collection of all feature point/frame pairs retrieved from one image is called 6D feature point cloud. It is efficiently implemented as map sorted according to the keys that are computed from the feature point descriptor vectors. Each key is associated with a list of object frames. Thus the cloud is not stored as a long list but as a set of shorter lists that allows for faster elements search. Object models can now be constructed by computing 6D feature point clouds of the object from different views and registering them into one object model cloud. In order to do this the frame between cloud pairs with matching keys is estimated on the basis of a voting strategy that iteratively casts single pose hypotheses into a 6D cube of discrete translation and orientation intervals that accumulates an average measure of all votes in each 6D cell. The cell with most entries is used to gain the 6D pose by some interpolation method.

First, the object appearances are segmented from the background using range segmentation. This type of figure-background separation can be realised by computing the shared image (see above) only for points in a specified 3D region (e.g. a sphere). Then the view dependent feature points are computed. Finally the different feature point clouds are registered into one object model. The object model is then used for 6D detection by applying the voting method described above to estimate a frame between the object model cloud and a scene cloud captured from the environment. The described method is currently being implemented and tested on the Care-O-bot 3 as a basis for fast and robust object grasping.

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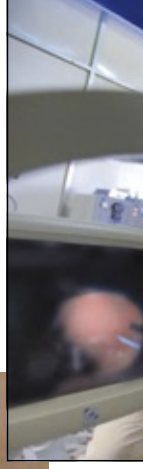
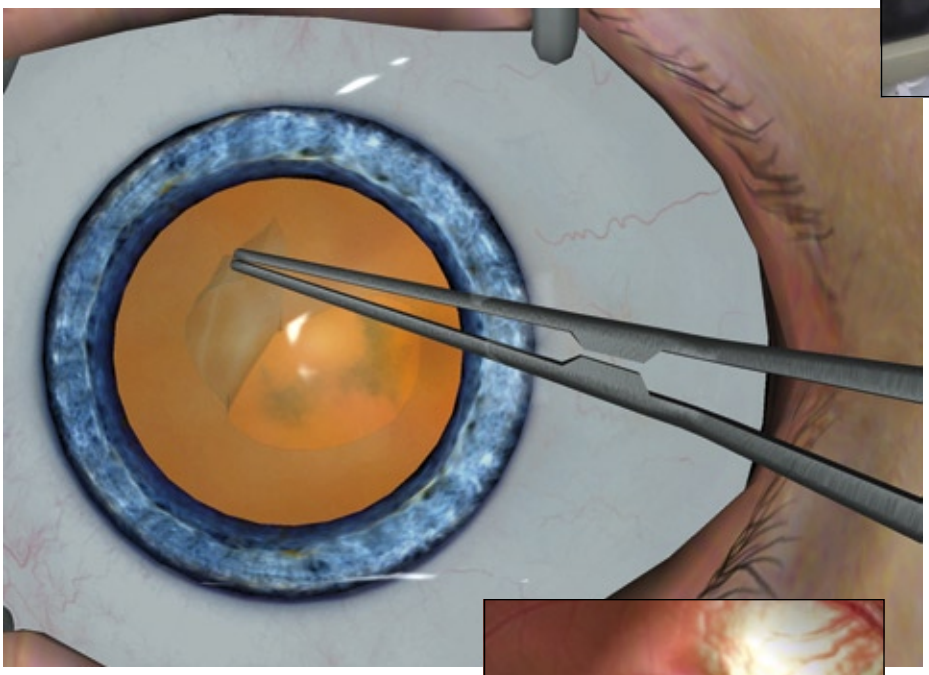
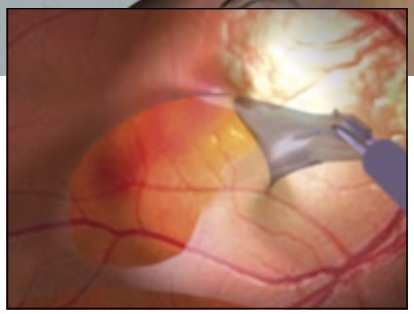
It's Magic

FPGA-based Tracking Enables Highly Realistic Eye Surgery Simulation



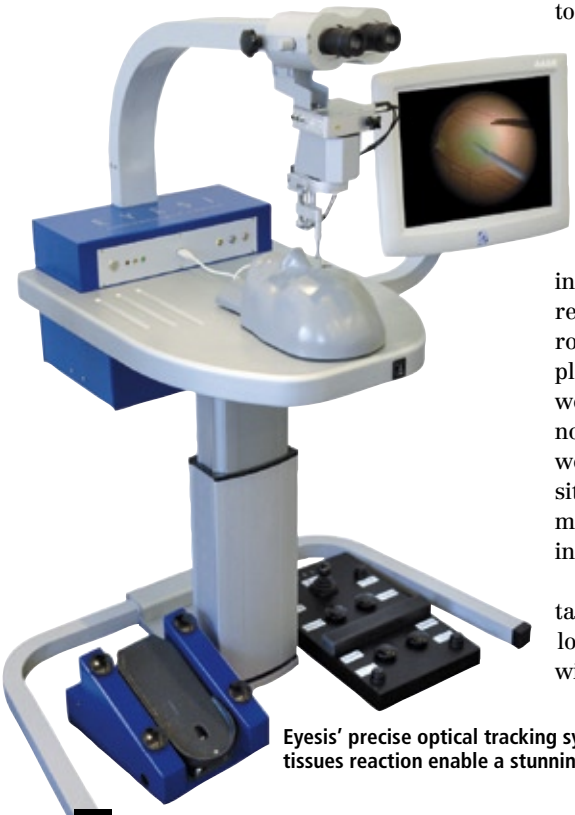
"We are magic!" – this was the slogan printed on the t-shirts of the three young men who carried a large black box into the exhibition hall at the annual conference of the German Society of Ophthalmology (DOG) in Berlin in 2001 and caused quite a stir as a result. What the specialists at the conference saw afterwards did indeed have something magical about it: for the first time ever, three young scientists from the Universities of Mannheim and Heidelberg demonstrated how eye surgery could be trained in a highly realistic way using a computer-based simulator – without a patient or animal eyes.





The surgical scenario is computer graphically generated and then rendered to the microscope, views are calculated for left and right eye giving an excellent stereoscopic insight into the eye

Previously, students of ophthalmology had practiced their first attempts at surgery on pig eyes before they were allowed into the operating theatre under the guidance of a professor. The possibilities for gaining actual surgical experience were therefore limited and always involved a certain residual risk for the patient. The new system with the name "EYESi" had been developed by an interdisciplinary team of computer scientists, physicists and medical specialists as part of a research project on "Virtual reality technology and medical simulations". The goal of this project was to develop a VR simulator that would allow doctors to practice surgical operations without any risk to patients – similar to the principle employed in training pilots using a flight simulator.



Eyesis' precise optical tracking system and optimized simulation algorithms for tissues reaction enable a stunning degree of realism

Surgery in Cyberspace

Surgery inside the eye is one of the greatest challenges in the field of microsurgery. The specialist training of eye surgeons takes two years. "We integrated all the important aspects of a real operation into the simulation environment when developing Eyesi," explains Dr. Markus Schill, who led the working group at the university and is now CEO of VRmagic Holding AG. "When working with the simulator, the surgeon sits in the usual position at an operating microscope and inserts original surgical instruments into a model eye."

The model head of the simulator contains an optical tracking system that follows the movements of the instruments with three cameras and supplies corresponding position information to a computer. The system simulates in real time how the tissue reacts when it comes into contact with the instrument.

"The use of simulators offers a number of advantages for medical training: all human pathologies – even rare cases – can be simulated, the permanent availability of the simulator saves both time and costs, and the training units can be repeated any number of times. In addition, the data provided permits objective assessment of surgical performance," explains Schill.

Award Winning Success

The positive feedback on the simulator when the prototype was presented in 2001 was sufficient encouragement for the research team to develop the product to series maturity. The company VRmagic GmbH was founded when Eyesi received

Eyesi in operation in Da Nang, Vietnam (Credit: PJ Saine/ORBIS International)

the Innovation Prize of the Rhine-Neckar Foundation of the Manfred Lautenschläger Foundation in the same year.

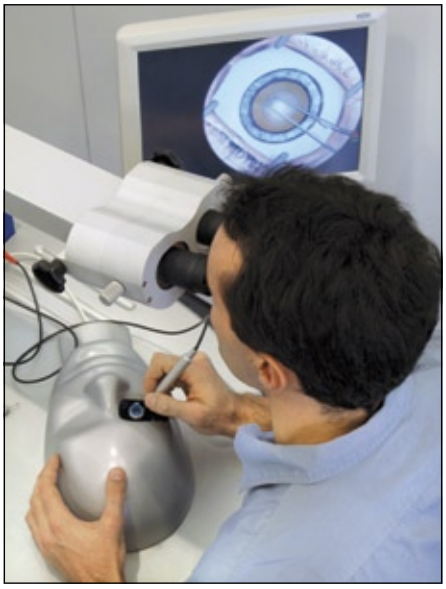
In 2004, the simulator received the award for the "Most Innovative Product" from the British Royal College of Ophthalmologists in Manchester, England. This was followed in 2007 by the "European ICT Prize" of the European Union.

Eyesi has been in use on all continents since 2006. In the U.S., the use of simulators was included last year in the new guidelines for ophthalmological training. The international non-profit organization Orbis, which fights blindness all over the world, has equipped its "flying hospital" and various national programs with Eyesi simulators in order to train eye surgeons in developing countries on the surgical techniques for removal of cataracts.

"We still often get enquiries from doctors asking us how frequently it is necessary to change the pig eyes in the system," smiles Schill, and his evident enthusiasm for the subject matter shows the amount of passion that has been incorporated in development of the simulator. Highly sophisticated hardware and software are needed so that the user actually has the impression that he is really performing the simulated operation. The time delay of visual imaging must be below the human perception threshold of 50 to 100 milliseconds. Powerful algorithms were developed for Eyesi that calculate in real time the behavior of fluids and tissue upon collision with the instruments and after tearing or deformation. Visualization of the space inside the eye is extremely realistic thanks to special effects such as shadows, selective focus and spotlighting.

Highly Precise Tracking in a Tiny Space

The demands on optical tracking of the surgical instruments inside the eye are very high, particularly because the instruments and lights should be freely movable. The relatively small volume of the eye must be scanned with high resolution in order to permit realistic simulation. The update rate must be higher than 30 Hz,



During simulated surgery, the surgeon manipulates realistic handheld instruments which are inserted into an artificial eye

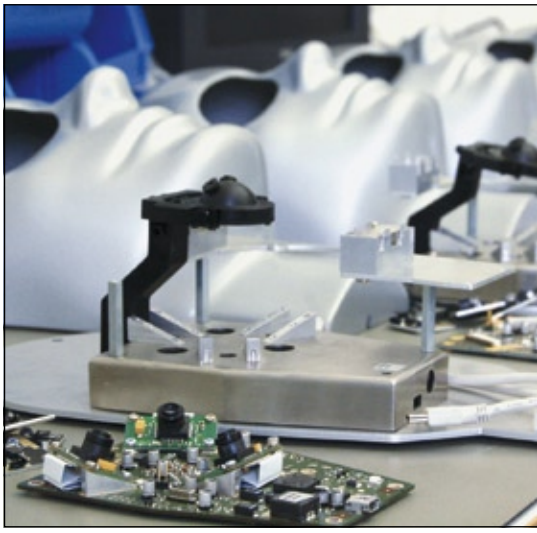
even with minimum latency, so that the computer graphics can produce a delay-free representation of the operation.

Movement of the instruments is followed by FPGA-based tracking: the swivel-mounted, mechanical model eye has color markers. The tips of the instruments also have a color marking. This makes it possible to determine both the position and the alignment of the eye and instruments. The markers on the model eye and instrument tips are projected onto the sensors of three calibrated FPGA cameras. After image processing in the FPGA, the 2D images are forwarded to a PC via a USB connection. 3D reconstruction takes place here. The image data of the three calibrated cameras is fusioned and triangulated in order to determine the precise spatial position of the instruments.

The camera system has become smaller and smaller over the course of the years. "On the first prototype, there was still an enormous box under the unit to accommodate the cameras, wiring harness and FPGA technology," remembers Thomas Ruf, who developed the FPGA-based tracking system for Eyesi and is today the head of Research and Development at VRmagic. The complete tracking system has been incorporated in the model head of the simulator since 2004. As a result, it is possible to easily replace the head in order to train different operations. USB compatibility was a prerequisite for simple interchange of the peripheral devices.

Simulator Cameras Branching out

Since there were no USB cameras offering sufficient performance on the market at the time, the developers at VRmagic started to build their own components.



Advanced optical 3D tracking technology for realtime eye surgery simulation

This led to the presentation of the first certified USB 2.0 camera in Mannheim in March 2003. Inquiries from industrial and scientific customers provided VRmagic with the encouragement needed to further expand the range of functions offered by the cameras. A second field of business therefore developed. Since 2003, the Stemmer Imaging Group has been the sales partner responsible for selling VRmagic cameras throughout Europe. The product portfolio now includes over 70 components – ranging from simple streaming components that forward image data to a host system and smart FPGA components for data pre-processing through to intelligent cameras that have a separate operating system and take decisions autonomously.

"We are our Own Most Critical Customer"

Often, VRmagic first develops new image processing components for its own needs. "We work with our SDK ourselves, so we know what features are important for developers," explains Thomas Ruf. Recently, a pixel-synchronous multi-sensor camera was developed for a medical training system with augmented reality. VRmagic will present this new camera with up to four remote and freely positionable sensors at the Vision 2008.

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And the Winner is …

Cinema Will Become Digital – Implications for Cinema Projection Lenses

"Ben Hur", "Star Wars", "Titanic" – these movies are known to everyone, and most people have also enjoyed them on a large cinema screen. Movies have been part of our culture for more than 100 years. Who hasn't hung at the edge of their seat – hoping and fearing with the characters on the screen? Frequently, movies are the topic of discussion for weeks.

© Quelle: Flickr, Donna Grayson

But often enough, how movies are projected onto the cinema screen is the subject of wild speculations and even seems mysterious for many. Frequently, one only sees dim outlines of large projection equipment and huge film reels. From a tiny window at the rear of the cinema theater, a blinding beam of light creates moving pictures on the screen. And the projector's monotonous clatter generates a quiet background noise as it churns thousands of meters of film through its mechanism every evening. 35 mm film material – the global standard in cinemas for more than 100 years. Even a 50-year old copy of "Casablanca" could be shown in every modern multiplex cinema, and a Japanese film of the 1930's can be viewed without problems in a cinema in Mexico or Kazakhstan. Schneider-Kreuznach has been a partner to the film industry for more than 95 years, and Schneider lenses are used even in the smallest cinemas in the remotest countries. Analogue projection technology with 35 mm films is found in every cinema worldwide.

Fig. 1: Cine-Digitar CDA 1.25x XL anamorphic D-Cinema attachement

The Future is Digital

"Digital projection" – movies in consistent top quality, without scratches or jerky images, in brilliant colors and with impressive sound effects – that is what projector manufacturers and the large Hollywood studios promise. Regarding the actual image, this can only be achieved with high-tech optical systems, whose performance sometimes approaches the technical and economically feasible limits. Remember: an image created by a chip measuring about 1.2 inches in the diagonal must be projected onto a screen with a width that often exceeds 20 meters. The slightest flaw in the lens or in the projector's calibration results in catastrophic, visible defects of the image projected onto the screen. Naturally, optical systems with even better performance exist, e.g. for the semiconductor industry, but these are in a completely different price category – a single lens costs more than the entire cinema theater – and they are used only in clean rooms under tightly controlled conditions. In contrast, cinema projection lenses are used all over the world under widely differing ambient conditions, from tropical regions as in South India to cinemas close to the Arctic Circle.

Asia	959
Europe	1,076
North America	4,885
Latin America	16
Total	6,936

Table 1: Digital cinema installations
(Source: DCinemaToday.com)

Optical Image Expansion

One of the basic prerequisites for optical systems for digital cinema projection is the ability to handle the two most widely-used widescreen cinema formats "Flat" with an aspect ratio of 1.85:1, and "Cinemascope" with an aspect ratio of 2.39:1. These two film formats are adapted to the cinema screen by means of different focal length and variable masking according to the aspect ratio. Because the projector's native aspect ratio is 1.89:1, presentation of Cinemascope images needs often a compromise regarding resolution and brightness. An anamorphic lens attachment can solve this problem. However, this requires electronic rescaling from the original image with a resolution of 2,048 x 858 to the higher resolution of 2,048 x 1,080. The image is extended vertically to an aspect ratio of 1.89:1. By means of an anamorphic at-

tachment mounted in front of the projector lens, the image width is expanded by 25 %. As a result, the image has the correct aspect ratio of 2.39:1 and fills the screen completely. In this case, it is not necessary to change the basic focal length. Schneider-Kreuznach is one of the few optical companies offering such special anamorphic lenses (Cine-Digitar Anamorphic CDA 1.25x XL, Fig. 1), and the only supplier who manufactures these lenses according to the tough environmental regulations for cinema use.

If the use of an anamorphic lens is not wanted in cinemas with constant image height, the focal length must be reduced to obtain a full-screen display of a Cinemascope image. This is possible with zoom lenses that have an adequate zoom range or with fixed focal lengths and an insertable extender lens with factor 1.25 x. Schneider-Kreuznach has integrated this additional extender function into the basic lens (e.g. Cine-Digitar Extender CDE 2.5–3.2/44–55 mm, Fig. 2), which permits a significantly more compact design and simpler automation of the format change.

Fig. 2: Cine-Digitar CD 2.5/ 44mm D-Cinema lens

Advance to 3D Projection

Meanwhile, digital cinema projectors with a resolution of 4K (4,096 x 2,160 pixels) are available – an obvious advantage for detailed projection and display. As the entire chain of image signals from film exposure to projection has not yet been adapted to 4K resolution, it will be a few more years before this new technology finds widespread use. Of course, laser projection or high-res LED vidiwalls are an option, but apart from technical problems, certain safety aspects (laser projection) or cost factors (LED vidiwalls) must be taken into account. One technology that will be widely used as early as next year, is the 3D display of films in cinemas, as has already been implemented in IMAX cinemas for quite a while. 3D-projection will be the next large technical advance in cinema projection – comparable with the change from black/white to color films.

Oscar for Lenses

During the next 15 to 20 years, cinema suppliers will face an enormous challenge: more than 130,000 cinema theaters worldwide must be converted from analog 35 mm film projection to digital projection technology. So far, only some 7,000 theaters, mainly in the USA, have been equipped with digital projectors (Table 1). It is very likely that we will see numerous changes in projection technology during the entire conversion period. Moreover, it is now possible to watch movies at home in "cinema-like" surroundings which is a new competition to traditional cinema. Schneider-Kreuznach also offers suitable basic lenses and anamorphic adapters for the high-end home cinema market. Also here, more than 95 years of experience in the professional cinema market play an important role. This long history is based on outstanding developments in the optical field, which set new standards and enjoy global use in premium cinemas in practically every large city. The successful lenses have already won four Technical Achievement Awards (Technical Oscar) in Hollywood – the last one in 2006 for the Cinelux Première series.

In the coming years, we will see dramatic changes in cinema projection technology, plus even greater possibilities through the introduction of digital projection. Meanwhile, the cinema business is also investigating the display of alternative contents such as sporting events or concerts. Similarly, interactive gaming events are already in the testing phase. All of this will also lead to changes in the demands and quality criteria for cinema projection lenses. The trend is clearly towards systems with higher resolution and better contrast, which places special demands on lens design. And perhaps 20 years from now we will still be able to watch "Star Wars" in a cinema, but in brilliant 3D and with interactive features. Nonetheless, the old Hollywood rule "The story makes the film" will be decisive – not the technology, which will always be a means to an end, although a very important one.

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In Clear View

Autofocus Camera Module for Screen-reading Aids

The macula is the area of the retina specialised in vision acuteness and clearness. We use this part of the eye for object location. A damaged macula allows us still to discern contrasts, but details can no longer be identified. The most frequent form of macula disease is macular degeneration, a primary age-related cause today for loss of sight in people over 55. The changed age structure in our society means the amount of people affected by such illnesses has now significantly increased.

An estimated two million people in Germany are reported to suffer from a form of macular degeneration. And when these patients want to read a newspaper or a book, they are dependent upon screen reading aids with a very high magnification.

Hedo Reha-Technik GmbH specialises in the development and production of such screen readers. The latest product from the Munich based company is the hedoView screen reading aid in which the Sentech STC-AF56 autofocus camera modules, supplied by the German distributor Videor Technical, are installed.

Screen reading aids fitted with high high-power camera modules assist the elderly in reading text and viewing image documents

Flicker-free Picture and Autofocus

The easy to operate magnification system with a TFT flat screen, autofocus, colour/B&W display delivers a flicker-free picture with high contrast. In addition to the true-colour display, it is possible to reproduce texts and objects in black and white as well as in pseudo colours. According to the hedo Managing Director Jürgen Mai, its outstanding features were decisive in the choice for the camera from Sentech: "The autofocus features of the STC-AF56 track the object and automatically adjust the sharpness, which makes it very much easier to read books with curved pages for instance."

hedo Managing Director Jürgen Mai: "The installed Sentech STC-AF56B Camera Module delivers the requirements necessary for usage in reading aids."

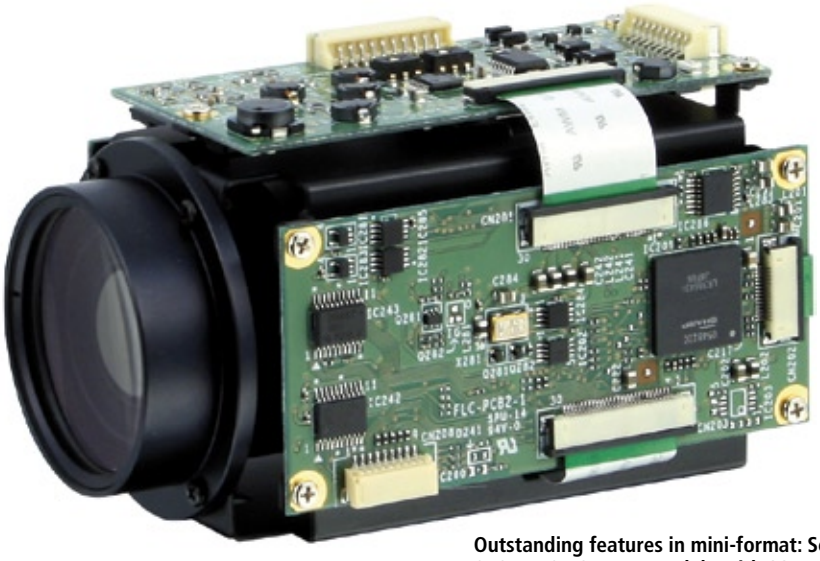
The two different models of the camera make it possible to view photographs or pictures in newspapers in grey or true-colour mode. As people with impaired vision also frequently have the problem of discerning black text on a white background, the camera also has a pseudo-colour generator that changes the colours of the background and text in several combinations.

Several Hundred Parameters

This feature can be used to change black text on a white background e.g. to yellow text on a blue background or different combinations.

Mask and line generators aid navigation through long texts. The "anti-focus-hunting" feature prevents troublesome camera refocusing whilst the object being read is moved to and fro horizontally. The 22x zoom lens of the STC-AF56 covers a focal length from 3.9 to 85.8 mm and directs its light onto a 1/6" CCD sensor. As an option the camera also delivers a CVBS and YC signal, though in NTSC, since the camera output has been optimised to 60 Hz VGA. A line-doubler and a scaler prepare the video signal so that the camera can be connected in progressive mode directly to a TFT screen or a projector with a VGA input.

The camera's RS-232 interface allows direct access to the digital signal processor upon which several hundred parameters can be configured. The zoom, focus and all special functions are also operated over this interface, assisted by the free bundled software. The protocol is open source so that customised user concepts can be developed. As an alterna-



Outstanding features in mini-format: Sentech STC-AF56B Camera Module with 22x zoom

tive, the main functions are also executed over hardware to allow simple operation by keystrokes.

Ergonomic Handling – High Functionality

Hedo Managing Director Jürgen Mai is satisfied with the new development: "We concentrated on ergonomic handling and high functionality during development of our new screen reading aid. Because our experience is that the elderly and vision impaired use it for filling out important forms as well as for completing crossword puzzles, sewing or making things. Automatic focussing allows them to concentrate fully upon reading the object. Integrated illumination gives nearly shadow-free lighting and gives a high-contrast display in different foreground and background colours."

As well as the system's standard 17-inch TFT display, other third party flat screens with a weight up to seven kilograms might be used and can be adjusted in height and angle. Additionally, there are optional extensions such as superimposing lines, masks and markers for improved readability of text.

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Not a Single Fish Gets Away (Without Being Counted)!

Machine Vision Solves Unusual Tasks

Trout, (a member of the Salmon family) are one of the most domesticated of our fish species, and are farmed within systems designed to mimic the Trout's natural environment as closely as possible. To thrive, Trout demand clean, fresh, well oxygenated water, a very specific diet and careful management. As trout grow comparatively slowly, it can take as long as 16-18 months to achieve a size which the consumer requires, and during this time the trout is constantly nurtured and cared for to ensure the highest survivability. With all this cost and effort involved, it is important for the breeder to exactly know their success rate – even if it takes rather unusual measures to achieve this.

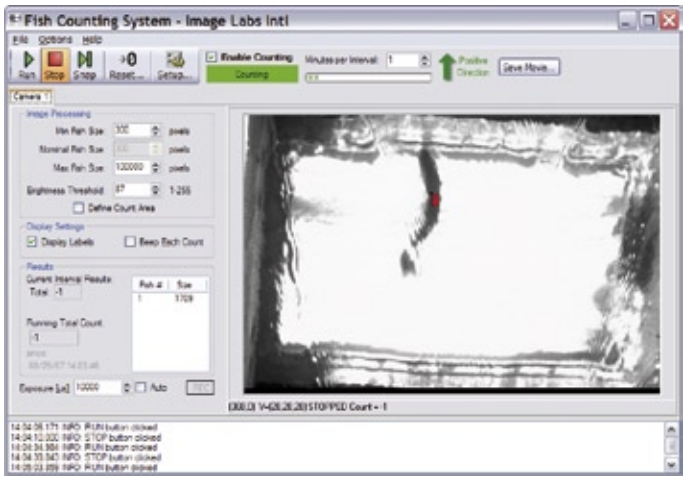
© Source: Flickr / literarymind

A fish breeder from Washington state approached Image Labs International with an inquiry regarding an application that initially invoked disbelief at Stemmer Imaging´s American CVB partner. The breeder wanted to count how many young trout swim out of his breeding basin into open water at the end of the breeding period. The large number of parameters initially made this task appear impossible to solve: detecting and counting moving organic objects in water is not exactly a standard function in image processing.

However, Image Labs managed to successfully solve the onerous assignment with the aid of the CVB Foundation Package and Visual Studio 2005 C# from Microsoft. According to Image Labs, the simultaneous recording, display and analysis of the images provided by five video cameras are the main features of the system. Each of the cameras monitors a different outlet from the breeding basin. The locations are each illuminated by waterproof background lights. This constellation allows separate analyses to be carried out for each camera location.

CVB Image Manager and various CVB presentation components are deployed for this part of the task.

The fish and their direction of movement are detected using the CVB Blob tool. The system counts only the number of fish that leave the basin. Trout that swim back into the breeding basin are deducted from the current total. To verify the numbers counted by the image processing system, there is an option to record video sequences on hard disk using CVB Movie for manual inspection at a later time.



A complex task: detecting and counting fish

CVB Blob solves the problem

Common Vision Blox 10 for Vista

Stemmer Imaging just recently announced version 10 of the Common Vision Blox (CVB) programming library. In addition to CVB's well known hardware independence and unrivalled connection flexibility, Version 10 includes support for the 32-bit version of Microsoft Windows Vista and a brand new, highly optimised installation routine.

Version 10 also complies with Microsoft's OS design rules for genuine Vista support, so that the new features and strengthened security it provides can be used in conjunction with Common Vision Blox.

The Common Vision Blox installation routines have been fully revised and updated for this release. With Version 10, CVB offers a modern installation procedure that sets new standards in user friendliness. To avoid unnecessary delays when using the installation program, the system's developers felt that it was particularly important to keep any user prompts to an absolute minimum. In addition, no further system restarts are required, even after the installation of the hardware drivers. Once installed, all other system settings can be accessed via the central management console which is another new feature in CVB 10.

The compilation of customised installation routines required to transfer proprietary CVB based applications from one machine to another have been greatly simplified – a feature that is particularly useful for system integrators and application companies. The target group of customers benefit in two ways from this new version.

CVB Version 10 is available for download at: www.commonvision-blox.com. This update is of course, free of charge for registered users of Common Vision Blox. A free 14-day full version is also available for evaluation purposes.

Stemmer Imaging´s machine vision library Common Vision Blox

Along with the speed demanded for recording and analysis, other factors favouring the use of Common Vision Blox were the short system development time (made possible by the use of ActiveX technology) and the high level of flexibility provided by the hardware. In the view of Image Labs, this strength of CVB was particularly crucial in the test phase, during which a number of hardware concepts were able to be evaluated without having to change the software code.

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Traffic Participants at a Glance

Smart Cameras in Traffic Security and Surveillance Applications

Mounted smart camera mvBlueLynx with removed weatherproof housing surveilling traffic on the Ardeche

Current traffic statistics unearth the truth: Due to increasing traffic, each road user is more stressed. This leads to low driver attention and mistakes which increases the accident risk especially at ambiguous and confusing traffic sites. Intelligent, robust and compact systems are needed to examine and protect traffic sections, even in poorly accessible environments. Matrix Vision's smart camera mvBlueLynx shows how traffic security is improved on land and on water in France.

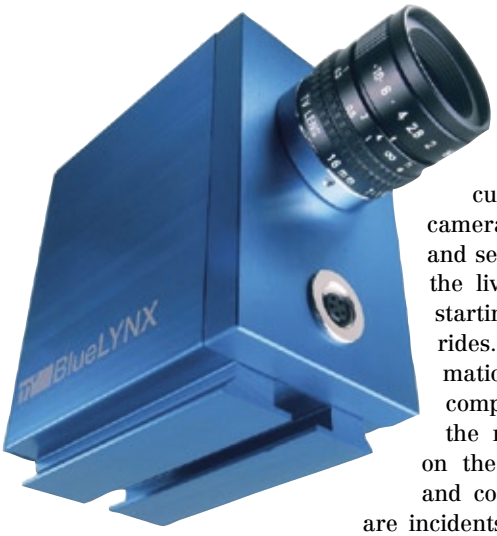
Dangers Caused by Wrong Way Drivers

According to the German Statistisches Bundesamt, there were approx. 340,000 accidents with personal injuries in the year 2004. Wrong way drivers account for 0.45% (approx. 1,800) of these accidents. This seems to be a small amount, however due to material damages, medical treatment etc. these accidents result in costs of approx. 35 million Euros per annum. In Austria, these numbers are comparable. At mid-year 2005, the number of wrong way drivers in Austria rose by 10% to 233 (source: Ö3 Verkehrsservice). In 2004, the total number of accidents was 42,500 (source: Bundesanstalt Statistik Österreich), which means that accidents caused by wrong way drivers correspond to 1 %. Reasons for wrong way drivers include drug and alcohol abuse, complex traffic signs near road works and motorway exits, inattention, suicide attempts and tests of courage.

Using Smart Cameras to Avoid Accidents on Motorway Exits

Taking the numbers from Germany and Austria as a base, there are approx. 820 motorists driving against the traffic in France (in the year 2004 there were 109,000 accidents with personal injuries in France; source: French Ministry of the Interior). For this reason, in 2005 some French motorway associations installed a smart system to prevent accidents. The system is based on the mvBlueLynx smart camera with an additional weatherproof housing and works independently. This means that the system features a transmitter and receiver. Furthermore, due to solar elements, no additional power supply is necessary. Thus, the intelligent system can record irregular incidents around the clock. Each camera observes one motorway exit and detects wrong way motorists, cyclists and pedestrians. The digital I/O generates a signal and sends it to a light system, which warns the offending road user visually. Of course, this does not prevent suicide attempts or tests of courage. However, the monthly downloads of the recorded images help to clarify the circumstances. In future versions, it would be possible to send the images of irregular incidents live to a central traffic surveillance center, which could then be used by the police or radio stations.

Watching out for wrong way drivers: mvBlueLynx located at a motorway exit



mvBlueLynx is a smart camera with a CPU up to 400 MHz, up to 64 MB RAM and Embedded Linux OS. The camera is available with CMOS sensors up to 1,280 x 1,024 pixels as well as CCD sensors with maximum of 1,600 x 1,200 pixels or as line scan up to 2,048 pixels.

Crowding on Waterways

Problems of this nature are not restricted to asphalt roads. Waterways are concerned, too. The river Ardèche, located in the south of France between Massif Central and the Rhone valley, is a popular destination for tourists from France and abroad. A popular attraction on the river is canoeing, as demonstrated by an increasing number of visitors. Nevertheless, there are disadvantages to increasing tourist numbers: the boat hire companies have to face an increased risk of accidents, tourists dissatisfied by a lack of solitude on the water and increasingly complex canoe traffic management. The latter actually led in some instances to attempts to defraud by tourists.

Traffic Management Supported by Smart Cameras

To counter these problems, at the beginning of 2005 the boat hire companies installed the mvBlueLynx smart camera with an additional weatherproof housing. The mobile and compact design pays off: neither a big housing nor a big power supply unit is needed to mount the camera on places with a good survey of the river and which are difficult to access. The camera counts the boats and sends the data and the live images to the starting point of the rides. With this information the boat hire companies can handle the number of boats on the river, intervene and counteract if there are incidents. The expansion of the system in every direction is also possible. The complete survey of the river is thinkable. Dangerous spots like hazardous shallow water could be marked in the system and image processing could detect whether a boat is approaching this danger. The system could also warn the canoeists or the hire companies to react.

Outlook

The current buzzword in the industrial image processing market is Gigabit Ethernet. Using Gigabit Ethernet has several advantages: high data rates, cable distances up to 100 meters, easy network mounting and Power over Ethernet. Furthermore, it is possible to use existing network infrastructure. Since 2007, Matrix Vision has combined Gigabit Ethernet with intelligence in one small camera called mvBlueCougar-P. This combination opens up new horizons, not only in traffic surveillance applications.

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info@matrix-vision.de
www.matrix-vision.de

All-Round Camera

With the VRmC-3+ Pro VR Magic presents a new and highly versatile entry-level camera for industrial applications. It is capable of performing a host of image processing tasks and offers a very attractive cost-benefit ratio. With dimensions of only 35 x 25 mm, it is one of the smallest C-mount cameras on the market, housed in an anodized aluminum case. The 1/3-inch CMOS sensor with global shutter is capable of producing 69 images per second at a resolution of 754 x 482 pixels. This makes the camera ideal for capturing both still images as well as fast motion sequences. It is available in monochrome and color versions with a high-speed USB 2.0 interface, allowing data transfer to a PC without additional frame grabber hardware.

VRmagic GmbH
Tel.: +49/621/400416-0 • info@vrmagic.com • www.vrmagic.com

High Brightness LED Light Lines

Vision Light Tech offers high brightness LED arrays. The optical, extruded side profile mechanical and electronic features are designed in such a way as to allow flexible adaptation to scalable lengths in steps of 150 mm from 300 mm up to 3,000 mm, output power and controllability of the units. The LED board design enables usage of different, even mixed-color LED types. In standard modules, high current LEDs are used for highest intensity and excellent homogeneity in diffuse applications. Alternatively Chip-on-Board-Technology (COB) enables adaptation to the requirements of reflective applications. The board temperature is continuously monitored to prevent overheating and thus damage to the LEDs and the modular heat sink concept comprises an active air cooling for standard or water cooling for high-end applications.

Vision Light Tech
Tel.: +31/413/260067 • info@vltusa.com • www.visionlighttech.com

Intelligent Vision Solution for Inspecting Parts

The Inspector from Sick is a compact 2D vision sensor for inspecting parts and products in varying orientations and positions and is as powerful as a camera and as easy to use as a standard photoelectric sensor. The ring or diffuse dome illumination, image evaluation and Ethernet interface are integrated in the IP67 metal device housing. Dome illumination is ideal, in particular, for glossy, highly reflective surfaces and provides a very homogeneous image. The sensor was developed for a wide variety of applications and its robust design stands up to the harsh environment of vehicle manufacturing.

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

11 Megapixel Camera with 12 Bit and Cameralink Interface

SVS-Vistek expands its large range of the SVCam camera line with a new 11 megapixel model called svs11002-12 with 12 Bit data format and CameraLink interface. This progessive scan monochrome or colour camera provides a resolution of 4,008 x 2,672 pixel using a Kodak Interline Transfer CCD sensor. The diagonal of the sensor is 43.3 mm which corresponds to the small picture format of an ordinary camera. The camera provides 6.3 frames per second. Much higher frame rates can be achieved in the partial scan mode with a reduced number of lines. Binning with 2 x 2 pixel is also possible. The Company's ConvenientCam software tool provides system integration and adjustment of the various camera parameters and operational modes such as gain, offset, exposure time, free running or triggered.

SVS-Vistek GmbH
Tel.: +49/8152/9985-0 • info@svs-vistek.de • www.svs-vistek.com

Access Control-Compatible Number Plate Recognition Camera

Sony Europe's Image Sensing Solutions Division has announced a highly integrated automatic number plate recognition (ANPR) camera covering formats from up to 25 European countries at a range of 3m to 18m to easily integrate with existing access control systems. The XCI-NPR uses the industry-standard Wiegand protocol, allowing OEMs to quickly and cost-effectively add ANPR capability to their products. Aimed primarily at applications within the corporate parking sector, the XCI-NPR transforms an existing badge-reader type access control solution into a seamlessly integrated ANPR system. It includes all of the hardware, software and interfaces that are required to integrate with bespoke or standard access control systems.

Sony Image Sensing Solutions
Tel.: +49/30/2575-500 • zone@eu.sony.com • www.sonybiz.net/vision

Sprint Line Scan Cameras

Basler Vision Technologies is introducing a new member of the sprint line scan camera family: the sprint 8k. A unique dual line CMOS sensor design provides outstanding image quality at a maximum line rate of 70 kHz and a resolution of 8192 pixel. Several useful features and a wide variety of accessories assure excellent inspection results and easy adaptation to the application. The line scan camera family is based on a pixel design combining the positive attributes of CCD and CMOS in a dual line sensor, designed to be extremely sensitive and to show very low noise. These features are critical in order to reach best results at low light conditions and the high line rates common in line scan applications.

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

Camera Family Completed

Allied Vision Technologies' building-block principles and a firmware upgrade enable over 2,500 possible variants of the Stingray camera family for machine vision systems to adapt quickly, simply, and economically to almost any application. Two fast FireWire IEEE1394b interfaces are provided for daisy chain multi-camera operation. Available are either two copper connections with screw-type connector for a stable connection of up to 20 m (see S. X), or a copper connection with a fiber-optic connection of up to 500 m. Behind C or CS lens mounts, six high-quality Sony sensors with resolutions from VGA of up to 2 megapixels, in black-and-white or color are available with a choice between neutral filter (protective glass) and four different IR-cut and/or IR-pass filters.

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

Intelligent Camera And Software

PPT Vision has announced the release of the new Impact A20 intelligent camera. Together with the bundled software suite, it delivers high-end machine vision power and flexibility in a vision sensor profile. The camera is industrially rugged yet compact, offering high-performance on-board image processing, a digital imaging sensor, real-time I/O and 256 MB of on-board memory. Within the software suite, the Vision Program Manager now has more than 120 tools, including OCR, blob analysis, circle gauge, circular pattern find, line find, sub-pixel gauging and many other advanced vision tools that allow users to create vision programs to suit a broad range of applications. A pre-configured operator panel is built within VPM so inspection data and pass/fail results can be displayed at the touch of a button, right within the same software application.

PPT Vision
Tel.: +1/952/996-9500 • info@pptvision.com • www.pptvision.com

CCD Cameras For Machine Vision

The Prosilica credit card-sized GB-Series Gigabit-Ethernet CCD cameras are single-board camera versions of the popular GC-Series GigE Vision cameras. The GigE Vision interface allows very fast frame rates and long cable lengths of up to 100 meters. Applications for the cameras include machine-vision, industrial image processing, industrial inspection, avionics, traffic-monitoring, license-plate reading, public-security, intelligent transportation systems (ITS), character-recognition, biometrics, robotics and surveillance. Features include snapshot shuttering, asynchronous external trigger and sync I/O, Region of Interest readout, AOI partial scan and flexible binning modes. They come with an adjustable C-mount with a CS-mount optionally available.

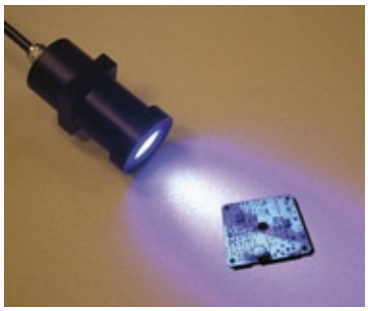
Rauscher
Tel.: +49/8142/44841-0 • info@rauscher.de • www.rauscher.de

Optics Lenses, Services and Components at Optatec

Docter Optics surprised visitors at this year's Optatec with a massive block of optical glass weighing over 200 kg. Nearly a meter wide, 15 cm thick and 69 cm high, this block demonstrated the extreme dimensions of the components that the Company can process. Its new facility in Triptis, Germany, is capable of sawing, milling, boring, grinding and polishing. Manufacturers can source virtually any conceivable type of semi-finished product, prototype or preliminary series produced to their specifications. The Company maintains one of the world's largest inventories of special optical glasses and can therefore offer customers a unique service.

Docter Optics GmbH
Tel.: +49/364/8127-0 • info@docteroptics.com • www.docteroptics.com

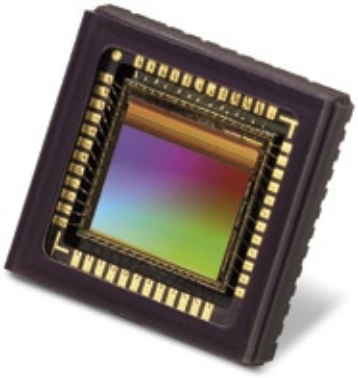
UV Spotlight for Machine Vision



The new 5 W UV spot light from iiM assists quality control and testing of features such as fissures in the casting or varnish of a surface that are not visible under standard lighting conditions. The new 5W UV spot light, delivered with two plastic lenses with a beam angle of 10 or 25 degrees, makes features that have been previously applied with a fluorescent agent shine under test and become visible both to human eyes and to cameras. The spot light in a compact aluminium housing is available in two variants: static or flashlight with times of 10–100 µs and a frequency of maximum 100 Hz or flash times of 20–220 µs and a frequency of maximum 35 Hz. The brightness can be adjusted either internally with a potentiometer or externally with a VC-voltage input.

iiM AG measurement + engineering
Tel.: +49/3693/88585-0 • info@iimag.de • www.iimag.de

Global Shutter CMOS Imaging



e2v has announced the availability of a new generation of custom high-sensitivity CMOS imaging sensors. A new, low-noise, full-frame global shuttering scheme uses high quantum efficiency (>80 %), CMOS sensor technology. This technology is particularly suited to performance-driven markets such as surveillance, homeland security, automotive driver active safety applications and industrial machine vision including barcode reading. The new sensors enable detection of small, fast moving objects or subtle contrast differences in everyday wide-dynamic scenes, which rely on the algorithm being supplied with high-quality image sensor data.

e2v
Tel.: +33 476 5830-00 • www.e2v.com

Versatile 5 Megapixel Camera

JAI announced the launch of a new 5 megapixel progressive scan camera in the Basic tier of the Company's new 3-tier C3 suite of cameras. The new high resolution 5 megapixel camera, equipped with a Camera Link (CL) interface, is available in two versions: BM-500CL (monochrome) and BB-500CL (raw Bayer color). Both models are built around the Sony ICX625 2/3" CCD sensor (2448 x 2050 pixels – QSXGA). They offer superb thermal management and pre-processing to guarantee optimal sensor operation, giving high quality images every time. Potential applications include automotive parts or glass inspection, traffic enforcement, fruit sorting on conveyer belts and facial recognition at security checkpoints.

JAI
Tel.: +49/6055/9379-10 • camerasales.emea@jai.com • www.jai.com

5 Megapixel Monochrome USB Camera

IDS has launched a high-resolution USB camera with a very attractive price-performance ratio, the 5 megapixel monochrome model uEye UI-148xLE-M. It is available in either a CE-B certified plastic housing or as a board level variant, with or without lens adapter. Drivers are compatible across the entire range. The camera has a 1/2" CMOS sensor with rolling shutter and 2,560 x 1,920 pixels resolution (QSXGA). Its light sensitivity and excellent level of detail meet the most exacting requirements of development engineers. Functions such as binning, subsampling, global start shutter and AOI mode, capturing up to 120 images per second, provide added flexibility.

IDS Imaging Development Systems GmbH
Tel.: +49/7134/96196-0 • sales@ids-imaging.de • www.ids-imaging.de

Industrial Cameras with Firewire B Interface

The Firedragon series progressive scan mono/colour CCD cameras from Toshiba Teli offer resolutions ranging from VGA (640p × 480p at 90fps) to XGA (1,024 p × 768 p at 36 fps), to SXGA (1,280 p× 960 p at 20 fps), and to UXGA (1,600 p × 1,200 p at 15 fps). The compact and vibration-resistant housing (44 × 29 × 44 mm) receives power through its 800Mbps FireWire b interface (IEEE 1394b, downward compatible with 1394a). Integrated image processing can output uncompressed raw image files with 8 or 10 bit per colour channel, 24 bit RGB data as well as compressed 16 bit YUV4:2:2 or 12 bit YUV4:1:1 data. Cameras supporting global shutter can image fast-moving objects free of distortion.

Framos GmbH
Tel.: +49/89/710667-55 • info@framos.eu • www.framos.eu

Fixed Focal Length Lenses for SWIR Cameras

Navitar introduces four new fixed focal length imaging optics specifically designed for SWIR (short wave infrared) cameras and applications and capable of offering high resolution images in conditions ranging from bright day light, fog/haze, twilight and dusk. Lens focal lengths include two 25 mm designs, a 35 mm and a 50 mm design. The new SWIR lenses are constructed for rugged environments and come standard with thumb screws for locking the focus and iris functions. Designed to cover 1" (16 mm diagonal) sensors, the lenses offer high resolution images and transmission in the 700–1,900nm wavelength of 75 % or better. These lenses are ideal for a variety of imaging applications where SWIR cameras are employed, such as perimeter surveillance, food sorting, toll-way monitoring, border and port security, quality control or aerial imaging.

Navitar, Inc.
Tel.: +1/800/828-6778 • info@navitar.com • www.navitar.com

Modular Vision Sensor Platform for Rapid Development

LMI Technologies has developed a complete modular vision sensor platform of hardware and software components under its FireSync brand. The system consists of a number of tightly integrated OEM hardware and software components and allows fast and easy integration of components into a scalable machine vision system along with microsecond synchronisation. Components include sensor controllers, camera and embedded sensors, machine vision software, industrial computers, lighting and others. The platform allows developing a single unified design for building vision applications ranging from smart sensors to complex web scanning systems, anywhere from specification to final assembly. It solves the classic problem of synchronisation between lighting, camera and processing components, permitting the development of a fully scalable design.

LMI Technologies
Tel.: +1/604/636-1019 • info@firesync.com
www.LMItechnologies.com

Endurance Cable Assembly Product Line

Northwire has introduced a new line of cable assemblies for vision system applications called Endurance. These are engineered with top-quality connectors and advanced, industrial-grade cables providing ultra-reliable interconnectivity in motion and vision system applications. Products for vision system applications include CCXC Analog Video, MVC-800 FireWire, GEV-1000 GigE Vision and Camera Link cable assemblies. CCXC assemblies meet industry standards for analog CCD cameras, are RoHS-compliant and have surpassed 15 million flex cycles of testing. MVC-800 assemblies come in standard 4.5 meters and extended distance/extended life lengths (type MVC-800EL) as long as 7 meters. GEV-1000 GigE Vision cable assemblies are designed to meet high flexibility industrial application requirements.

Northwire, Inc.
Tel.: +1/877/210-9950 • cableinfo@northwire.com • www.northwire.com/assemblies

Ethernet Cameras For Image Processing

Kappa has extended its camera range with Gigabit-Ethernet cameras. The GigE cameras are available with various sensors, in color, monochrome or cooled versions, with megapixel resolution, frame rates of up to 30/90 fps and short trigger delay. They now allow cable lengths up to 100 m/330ft (CAT5E). Special features like camera-internal color processing, camera-internal signature creation and a cooled version with special slow scan mode (67 dB) are also available in the model range. Camera control software tools include KCC, the software development kit (sdk3) for integration into third-party software applications and the application software KIB for measurement tasks.

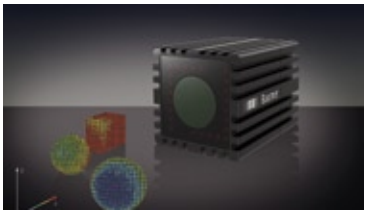
Kappa opto-electronics GmbH
Tel.: +49/5508/974-0 • info@kappa.de • www.kappa.de

Camera Support for Rapid Response Valves In Sorting Systems

Modern high-speed systems sort items like rice and peas or plastic items by colour, shape or size. Faster than the human eye can perceive, Festo MHJ rapid response valves blow bulk goods into various containers with perfect precision. At extreme speeds it is almost impossible to detect the cause of a fault in a motion sequence. The SBOC-M/SBOI-M intelligent vision system supports both diagnostics and commissioning of the sensor system, as well as function monitoring with an extremely high scanning rate of up to 2,000 images per second. The complete electronic system for recording and storing motion sequences is integrated into the camera.

Festo AG & Co. KG
Tel.: +49/711/347-0 • info-de @festo.com • www.festo.com

Digital 3D Camera For Spatial Sensing



The new Baumer TZG01 3D camera simultaneously provides a gray-scale image with a resolution of 176 x 144 pixels and a second image with real distance information for every pixel. This happens in real-time with up to 20 frames per second. Otherwise, the 3D camera behaves just like any conventional b/w camera. It is connected to the computer via an Ethernet network and can be controlled using the same generic GAPI programming interface as all GigE cameras. The camera is designed for industrial use in a very compact housing with integrated optics and illumination, no moving parts as well as protection class IP 67. Typical fields of application are luggage and package sorting, control of part completeness and presence, coordinate determination, volume measurement and robot guidance.

Baumer Optronic GmbH
Tel.: +49/3528/4386-0 • sales@baumeroptronic.com • www.baumeroptronic.com

Industrial Cameras, Software, Optics and Illumination Catalogue

The new Imaging Source catalogue contains more than 100 new GigE, USB 2.0, FireWire and zoom industrial cameras. These are available with CMOS or CCD sensors with resolutions of VGA, XGA and SXGA up to 2 megapixels and ship in robust, industrial housings. Some cameras are available with a trigger input and I/Os to control external devices. The zoom cameras have an auto-focus and allow all camera parameters and functions to be set from the shipped software. The catalogue also contains details of new ring and back light systems.

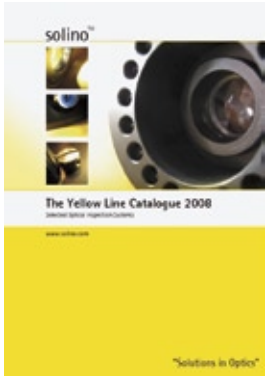
The Imaging Source Europe GmbH
Tel.: +49/421/33591-0 • info@theimagingsource.com
www.theimagingsource.com

CCD Cameras with Gigabit Ethernet Interface

NET (New Electronic Technology) releases Gimago, a Gigabit-Ethernet camera line. The range offers monochrome and color CCD image sensors from 1/3" to 2/3" with resolutions from VGA to UXGA. The latest 1/3" CCD delivers SXGA resolution and high sensitivity in the near IR-spectrum. The auto-iris lens control feature supports DC driven lenses to be used with the new camera series to control the incoming light via the lens iris. Also an opto-isolated trigger input and strobe output are integrated in the small 40 x 40 x 45 mm housing. All models are supported by viewer software and an SDK which is included free of charge and are compatible to Matrox and National Instrument libraries.

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

Catalogue Of Optical Inspection Systems



Opto has announced that it is further expanding its Solino brand by launching its new Yellow Line catalogue. This comprises a selection of some of the Company's most popular special optical inspection systems, and perfectly complements its established Green Line component business. Ranging from 3D-stereo and optical zoom systems including new Leica M165C all the way to mobile microscopes and OEM systems with their typical 5/8" adapters, this new line provides end users and OEMs with a wide range of high-end inspection solutions. It also includes systems for simpler applications such as magnifiers and pocket microscopes in addition to its popular Eco-Line microscopes and full range of Leica E-Series systems.

Opto Sonderbedarf GmbH
Tel.: +49/89/898055-0 • info@opto.de • www.opto.de

ID Readers For Complete Part Traceability

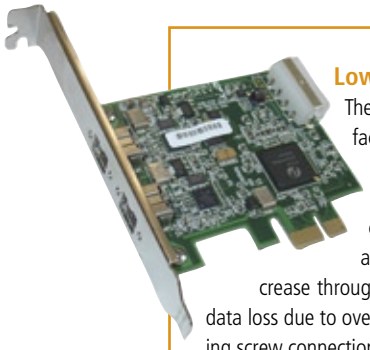
By deploying the DataMan 7500, DataMan 100 ID Readers as well as the In-Sight 5110 vision systems from Cognex, Borg Warner Turbo Systems in Germany tightened quality control of their turbocharger production. They implemented a traceability project to identify the individual code on a component and were able to create seamless traceability through the production process and beyond. Some 3.5 million turbochargers a year leave the production plant every year. After test runs, it was decided to apply an adhesive label with a 2D matrix code. The code can be easily read, even when dirty.

Cognex Germany Inc
Tel.: +49/721/6639-00 • info@cognex.de • www.cognex.de

Image Analysis Tools With Easy Licensing System

Euresys Open eVision 1.0 is a new suite of powerful and flexible software tools dedicated to image processing and analysis. It inherits the experience gained with the previous generation, is designed to be integrated into your application, and offers Libraries (DLLs), ActiveX controls, .NET classes and an extensive support of development environments. The distribution, installation and licensing procedures of Open eVision have been specifically tailored to the needs of OEMs and system integrators by including an ultra-modern, fast and safe software-based licensing system designed to help install the tools and deploy the application on any platform. There is a flexible choice of licenses including portable licenses as well as bundles, packs or an SDK.

Euresys s.a.
Tel.: + 32/4/36772-88 • info@euresys.com • www.euresys.com



Low-Profile Dual Bus 1394b PCI Express Card

The Firepro IEEE-1394b low profile PCI Express card designed and manufactured by Point Grey Research is ideal for multiple camera arrays or high data rate applications. A new dual bus option incorporates two 1394b physical layers to allow simultaneous image acquisition from up to 16 cameras, and total data throughput of 160MB/s, using a single host adapter. The FWB-PCIE effectively leverages the x1 PCIe serial link to increase throughput and minimize latency, and deep FIFO's minimize the possibility of data loss due to overflows. Each card is equipped with two bilingual 1394b ports with locking screw connection, and an internal power connector.

Point Grey Research Inc.
Tel.: +49/89/45463224 • eu-sales@ptgrey.com • www.ptgrey.com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18–21 November 2008 | Exhibition Center Basel
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1 ticket – 3 exhibitions: Your entry ticket is also valid for the concurrent production measurement exhibition, PRODEX. The combination of the two exhibitions means that you can take a "make-or-buy" decision when you are there. You can also visit the PACK&MOVE packaging and logistics exhibition with the ticket.
Off to Swisstech – for free!
Simply enter the priority code 428-A74U54A88R26 at www.swisstech2008.com/online-ticket
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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. Success stories with testimonials from users show not only the performance of technology in various fields, but also guide you to suitable suppliers for your application.


© Source: Flickr, 3eses

Protected Without Intrusion

Smart Eyes for Assisted Living

An elderly woman wanders about aimlessly in a home for assisted living. Suddenly, she collapses on the floor of a lonesome hallway. Usually it can take over two hours until a night nurse passes this spot on her next inspection round. But in this case she is already on site after two minutes, ready to help. She has received an alert message on her beeper: "Inhabitant fallen in hallway 2b". The source: the SmartSurv distributed network of smart cameras for automated and privacy respecting video analysis. Welcome to the future of smart surveillance!

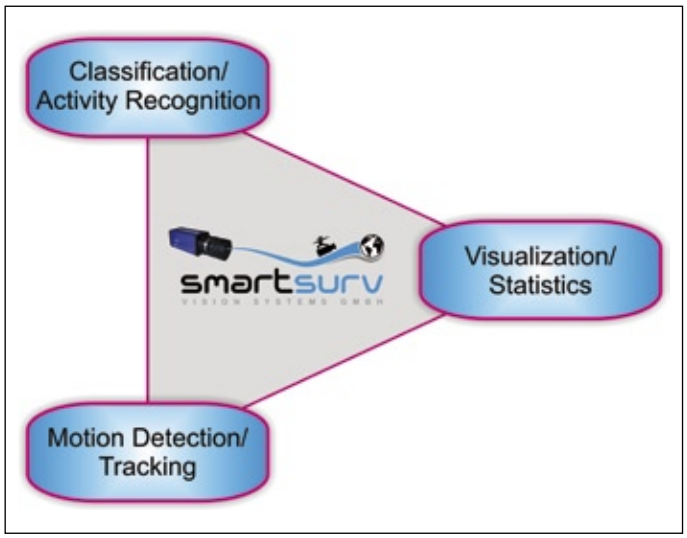
The demand for video surveillance systems is immensely increasing in various fields of security applications and beyond. Besides traditional surveillance scenarios at airports, train stations, government buildings and industrial plants new application areas are continuously emerging, e.g. assisted living, pool surveillance or customer statistics in retail. Current video surveillance systems however sport severe drawbacks due to their centralized and mainly manual nature. Privacy is an essential issue that video surveillance systems strongly ignore since they inherently rely on the analysis by human operators. Thus, the operators necessarily require access to all video streams. Additionally, it is necessary to transmit all streams to a centralized location. This requires a corresponding infrastructure capable of handling the necessary bandwidth and bears additional points of misuse, especially when wireless connections are used. Moreover, the video streams can be stored in an unregulated way. Another major problem today is that the security personnel is completely overstrained by the sheer mass of raw video data: According to a military study, after 22 minutes an operator will miss up to 95 % of all the scene activities.

Smart Approach

SmartSurv Vision Systems developed a distributed and automated architecture based on a network of smart cameras to address these problems, especially within the privacy sensitive field of assisted living.

The proposed scene analysis approach is based on the smart camera paradigm. In contrast to traditional computer vision systems today where cameras are seen only as simple sensors and the complete raw video stream is transmitted to a centralized processing unit, a different and more natural approach is chosen: what algorithmically belongs to the camera is also physically performed in the camera. The idea is to compute the information where it becomes available – directly at the sensor – and transmit only results that are on a higher level of abstraction. The proposed system can pre-

System installation in a home of assisted living



Core competences of SmartSurv Vision Systems

vent potential misuse of personal video data on the lowest level. No video feed has to leave a camera any more. The system presented allows for tracking in geo referenced world domain in contrast to image domain. It comprises embedded activity recognition and an innovative visualization of all results in one integrated world model.

Falling person detection is addressed as one major activity for assisted living systems. According to studies, falls are among the most serious health risks for seniors over the age of 65, affecting more people than stroke and heart attacks combined. Moreover, detecting falls to get immediate help reduces the risk of hospitalization by 26% and death by over 80%.

Machine Learning Philosophy

The underlying technology of the SmartSurv system comprises three major components that at the same time represent the company´s three core competences:

1. Motion detection/tracking
2. Classification/activity recognition
3. Visualization/statistics

Traditional vision systems strongly rely on application specific programming and daunting parameterizations specific to the respective scenario. SmartSurv instead favors an approach based on the machine learning paradigm to get closer to the long standing dream of adaptive, self learning and self contained vision systems that can be trained by presenting examples instead of programming. How this philosophy is integrated within the video analysis and what the results are for assisted living is surveyed in the following.

Motion Detection/Tracking

As the real world illumination conditions in surveillance scenes are not well controllable, it is essential for the detection and tracking of moving persons to have an approach that is capable of dealing with such situations, reflections and shadows. survMotion, operating on Matrix Vision smart cameras, is a new product from SmartSurv for intelligent motion detection with arbitrary user definable regions and a very robust background model that adapts to various sorts of illumination changes.

Classification/Activity Recognition

Based on the information of the survMotion component, the movement characteristics of each tracked person is analyzed over time using latest machine learning techniques embedded within each smart camera. As soon as the movement is classified as falling, this and only this information is transmitted via the network to be embedded within the common world model for visualization. Besides classification of characteristics over time it is also possible to classify static objects with this technology.

Due to the convincing results gained from the surveillance sector a product called survAce for industrial surface inspection has been developed together with a leading institute for machine learning based on the same underlying technology. It detects defects by generating an optimized classifier in a fully automated process on the basis of in-depth mathematical optimization. Again, this follows the approach of training instead of programming. Apart from

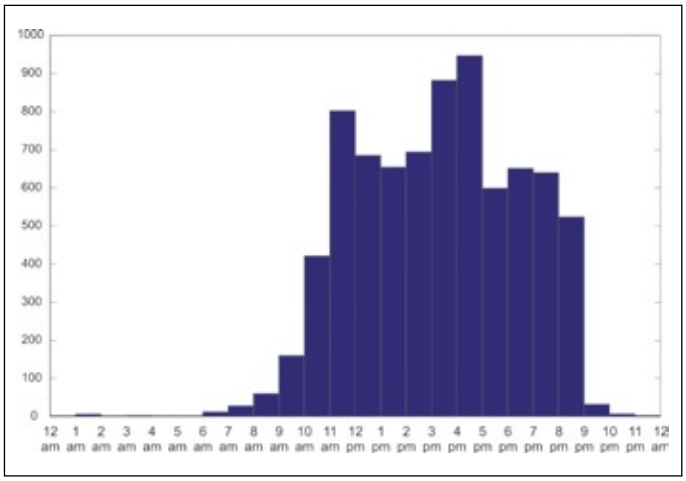
A person is detected as moving and is tracked automatically for further analysis (top), the movement is classified as fall (bottom)

a rough labeling of typical defects no manual intervention is required, yet full control over the classification process is possible via loss preferences. This software has recently received an "industrial optical inspection award".

Visualization/Statistics

The third component covers the visualization. All relevant and abstracted sensor information is integrated in one common and geo referenced world model. Based on this, an intuitive visualization is available that is fully decoupled from the sensor domain, i.e. independent of the respective camera that is actually analyzing a person. Both the position and the status of each monitored person are reflected in this virtual world as stylized icon. In addition to results from the camera network also other sensor information can be integrated within this visualization system called survViz.

Visualization of relevant information (position and status) of all objects currently analyzed by the smart camera network



Statistics of number of persons present within a hallway of the assisted living home: the peaks for lunch and dinner are clearly visible

It also comprises a statistics module to compute the duration of stay within regions defined in survMotion. Within assisted living, also the occupancy of the hallways can be evaluated.

Conclusion

To summarize, the presented architecture for tracking, activity recognition and visualization offers a promising approach for applications within the field of assisted living and beyond. The problems of traditional video surveillance systems are identified and addressed. Instead of overwhelming the personnel with raw video data, only the results (position and status of each person) are reflected in one world model that is visualized intuitively. Thus, both the privacy of the persons is preserved and the personnel can concentrate on more relevant information to help the elderly.

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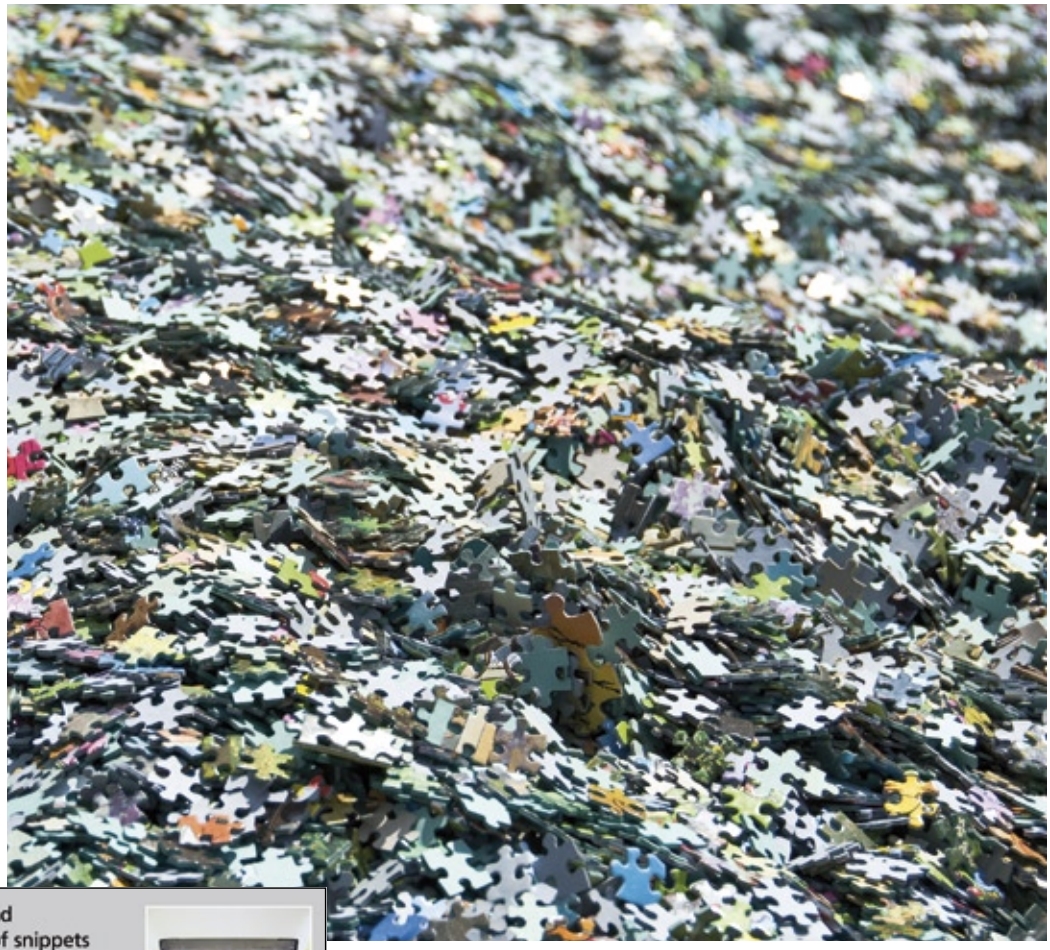
The World´s Biggest Puzzle

The Stasi Snippet Project – the Ultimate Challenge for Digital Image Processing

In autumn 1989, when the end of the German Democratic Republic was near, the headquarter of the Ministry for State Security (Stasi) systematically began to destroy documents because of the threatening political and societal turning point. Due to the gigantic amount of paper files the shredders broke down and the employees received orders to destroy the papers manually to complicate or hinder investigations in the future.



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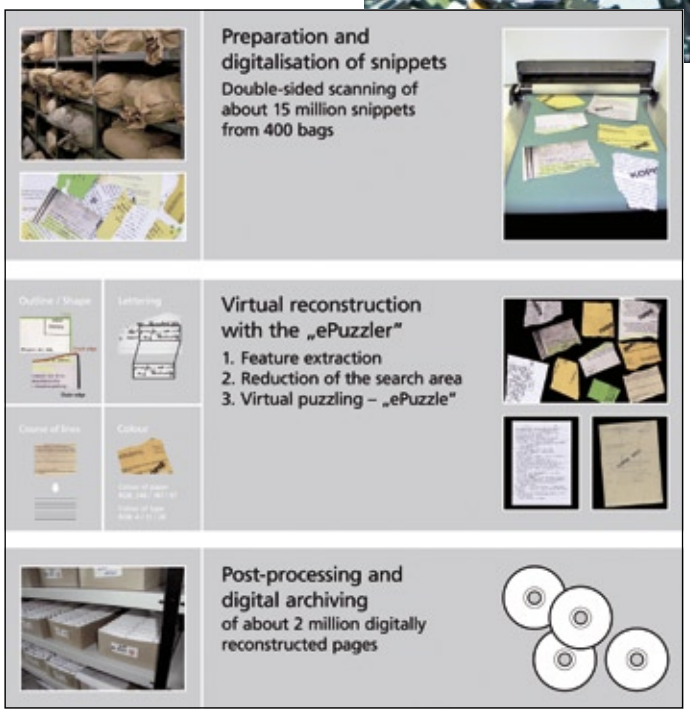

Fig. 1: Complete process. Before the reconstruction takes place, the snippets have to be digitised double-sided. The virtual reconstruction, consisting of three parallelized steps, takes place. As shown in the middle, different features of the snippets are extracted to find the right reconstruction partners. After a data transfer the snippets are processed and archived digitally.

(© Fraunhofer IPK, photographer: Armin Okulla)

These snippets with an extent of about 45 million torn pages in 16,250 bags are kept in the archives of the Office of the Federal Commissioner Preserving the Records of the Ministry for State Security of the GDR (BStU) nowadays. First attempts of manual reconstruction succeeded because the snippets of one page often are located in the same bag. But considering the amounts of pages, a personal and time effort of 30 people and 600 to 800 years would be needed to finish the reconstruction manually.

After a television report concerning the manual reconstruction of the torn documents of the Stasi in 1996, the idea of an automated virtual reconstruction was developed at the Fraunhofer IPK. A computer based reconstruction could immensely shorten the time effort und enable an analysis of the documents in the near future.

In 2002, the BStU initiated a Europe-wide competition for a study of computer based reconstruction. The Fraunhofer IPK and the Society for voucherless document processing (GbD) won the tender procedure against a grand competition. The allocation of the feasibility study resulted from an objective test scenario. Only the prototype of the Fraunhofer IPK could offer an acceptable solution. A concept was designed as the basis for the development of a system for the automated virtual reconstruction. By the means of this system a virtual reconstruction of all the bags could take place within five to seven years.

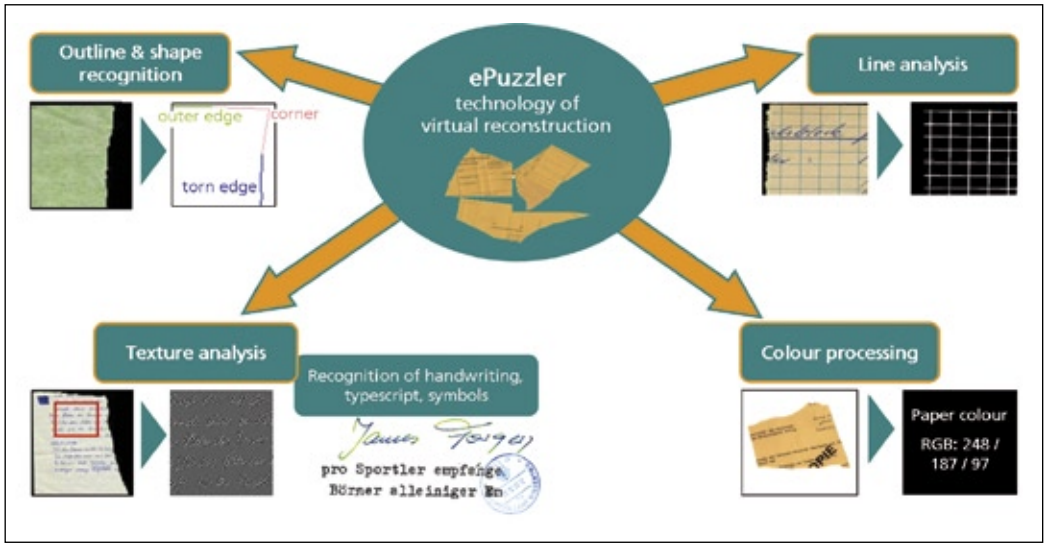

Fig. 2: The ePuzzler extracts document features like outline, shape, texture, lining and colour.
(© Fraunhofer IPK, photographer: Armin Okulla)

Solving the "Biggest Puzzle of the World"

Due to the experience gained from former projects of industrial image processing the Fraunhofer IPK could develop a laboratory system to prove the feasibility. On this basis, as shown in Figure 1, a system concept was generated. It is divided into:

- preparation of snippets and digitalisation,
- virtual reconstruction,
- workflow system and archiving.

Since there was no possibility to digitise the optically challenging snippets with standard scanners a specialized high speed scanning device was developed. This device enables a high throughput of snippets and has the ability to capture the front- and backsides of the snippets in an instant.

The system for the automated virtual reconstruction consists of three major modules: feature extraction, search area reduction and virtual puzzling.

The separation allows a parallel implementation of the general concept which is cascadable and is based on a high-capacity grid technology.

Feature Extraction

For the solution of a puzzle humans use a variety of features to decide if two pieces fit together or not. The developed system for the feature extraction, the ePuzzler, distinguishes between inner and outer features. Outer features especially contain information about the shape of snippets e.g. on which edge the page was torn. Inner features are, for example, colour and texture attributes as well as context related features like illustrations, handwriting, typescript or symbols on the inside of the pieces.

Reduction of the Search Area

The automated reconstruction of torn documents is based on calculated features. It's obvious that because of such a big data set which is to handle, there is no chance puzzling "straight on" after the calculation of the named features. The possibilities of combinations of the inspected pieces would become far too big.

The search area reduction is used to flatten the combinatorial effort. Due to the circumstances of manual filling in 1989, the material to be reconstructed is not dispersed over all the bags by accident. Most likely the single pieces of a document are in the same bag. Thus, sorts of layers were generated and there is furthermore the probability that reconstruction partners lie relatively close to each other. The layered arrangement is considered in the step of digitalisation.

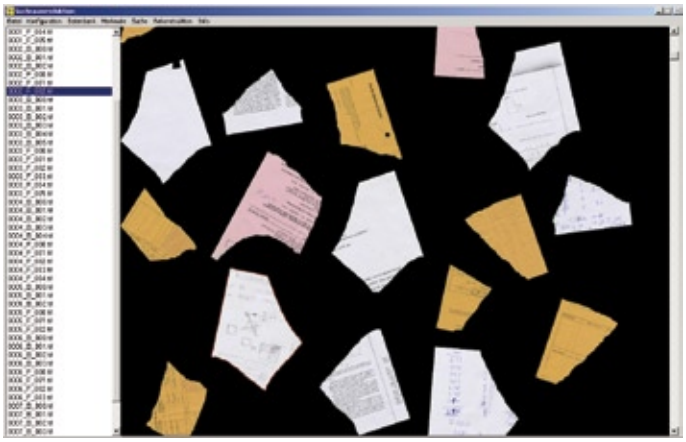

Fig. 3: In the second step of the reconstruction the search area is reduced by considering the circumstances of the manual filling of the bags. The developed layers are used to subdivide the search area. (© Fraunhofer IPK, photographer: Armin Okulla)

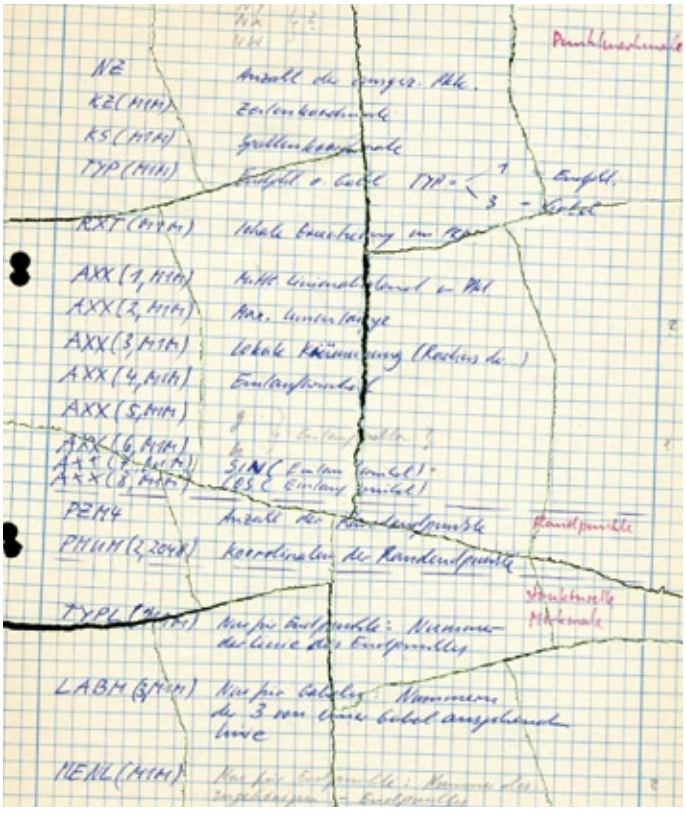

Fig. 4: Using the automated virtual reconstruction a torn page can be completely restored.
(© Fraunhofer IPK, photographer: Armin Okulla)

Fig. 5: The reconstruction-method could be used for explaining circumstances of crimes, e.g. by reconstructing broken glass. (© David Ritter)

Fig.6: Fragments of the arch in the Basilika San Francesco in Assisi (© Fraunhofer IPK, photographer: Armin Okulla)

With the help of the features described above the search area is further subdivided. In this way snippets with similar features turn out to be promising candidates for a reconstruction.

Virtual "Puzzling"

In the reduced amount of snippets in the search area the actual reconstruction takes place. Therefore snippets are compared along their contours. If matching snippets can be found, they are combined to a bigger part of a document. The features of this document are recalculated and considered as a new snippet during the further reconstruction. Hence this piece can be compared with the other snippets and successful partial compositions. Eventually the single pieces are merged until a complete document is created. The total volume of snippets is updated when all possible steps of reconstruction are realized on the group identified during the search area reduction.

Potentials of the Reconstruction Technology

Due to the positive media response to the feasibility of the automated virtual reconstruction the Fraunhofer IPK received a variety of requests. The developed method can be enhanced according to specifications from different fields of application.

- After the dissolution of oppressive regimes in Eastern Europe, South America and South Africa big piles of files were left behind. They are not torn like in the case of the former GDR but damaged as a result of aging and improper storage. Thus, these documents cannot be digitised offhand and are not available for the analysis of history (e.g. files of prisoners of Nazi concentration camps). A number of authorities in the world regions described above approached the Fraunhofer IPK and the BStU with the concern to use the experiences gained in the reconstruction of torn documents. Concerning the investigations of oppressive regimes and the reconstruction of damaged documents conversations with representatives of Chile, Poland, Romania and South Africa i.a. were held.
- Libraries, archives and research facilities often deal with historical and therefore – unfortunately often – damaged documents. By the use of our method for the automated virtual reconstruction a rearrangement of research relevant documents can be aspired.
- Plenty requests from national and international art schools, archaeological institutes, restorers and archives reached the Fraunhofer IPK. These requests normally concerned the reconstruction of three-dimensional objects.
- Forensic science could provide the task to reconstruct objects and materials, e.g. glass or ceramics, for the explanation of circumstances of offences. That basically is a very costs and time-consuming process. Via a computer controlled analysis this operation could be performed much more efficiently.
- For a value detection and investigations in cases of damage the reconstruction of objects would be interesting for insurance companies.
- Cultural heritage which was destroyed by atmospheric conditions or wars could be one field of application, too. A couple of requests already exist, for example of the Basilika San Francesco in Assisi, Italy. Because of an earthquake big parts of the arch purfled with versatile historical paintings and frescos was damaged.
- Within archaeological and art historical topics there might be challenges for the reconstruction of fossils and archaeological shards – and maybe therefore the determination of origin and former functions of objects.

Perspectives

So far the method developed by the Fraunhofer IPK is unique worldwide and can be regarded as a market segment not filled until now. This generates the chance to create new employments in science and economy.

While fully-developed systems exist for the digitalisation of three-dimensional objects, the 3D-reconstruction scientifically and technically stands at the beginning of its development. The Fraunhofer IPK will start a research project with companies, authorities and research partners concerning this topic.

Due to the high media response and popularity a center for the automated virtual reconstruction is prepared in Berlin.

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Non Touch and Fully Automatic

Fourth Generation of Wheel Alignment Uses 3D Vision Technology

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Wheel Alignment System Cura R 2000

As part of standard car maintenance wheel alignment consists of adjusting the angles of the wheels of an automobile so that they are set to the car maker's specification. The purpose of these adjustments is maximum tire life and vehicle-travel that is straight and true when driving along a straight and level road. The third generation of wheel alignment, that found its way into the market over a decade ago, was deemed to be a significant breakthrough in the automotive branch.

Life in the workshop became much easier as there were no more fragile sensor heads that could be dropped and broken or lose their calibration and also the run out compensation by lifting and drudgingly rotating individual wheels in both directions was done away with. Instead, targets were used to replace the sensors and the push and pull technique of compensation was born. This whole process worked much more elegantly than its predecessor.

There was, nevertheless, still a worry at the back of the mechanics mind. Next to the fact that an incorrectly mounted target could still ruin your day, was also the worry of having a customer watching how his shiny, expensive rims could be treated by the cruel fingers of wheel clamps that often left nasty scratches and marks on the rim surface. So, whatever was to come after 3D, had to fulfil two basic requirements: as little user intervention as possible on the car, and measuring without direct contact of the metrological equipment to the wheel.

Touchy Topic

Automotive Testing Technologies (ATT) had been demonstrating a high technology fully automated measurement and run out process with the Cura R 1200 series since 2002. The hydraulic operated automatic turntables and slip plates were integrated into the ramps and could enable each wheel on a single axle to rotate in opposite directions allowing a push and pull run out to take place avoiding any linear movement of the vehicle. The operator had nothing more to do than to select the model from the databank and carry out a very quick caster sweep at the end of the process. Two "robots" were positioned, one each side of the vehicle that traversed along the complete length of the ramps. Metal fingers then touched each wheel to ascertain the angles and retrieve the overall measurements. Although this was an innovative measurement process, it was still not what the workshops liked. They wanted the next generation of wheel alignment to be "non touch".

Dream come true

A fortunate coincidence happened when ATT met up with the industrial Automation and Drives Division of Siemens in early 2005. Quite unbelievable, we stumbled across what everybody had actually been dreaming of: A nice modular box that contained everything to measure distances and angles without any physical contact with the vehicle. 'Colour Coded Triangulation' was the word, abbreviated 'CCT', and definitely not to be confused with 'CCD', which is the type of camera most other applications are us-

ing today. It wasn't nice and modular at that time as it had only recently been developed but, believe it or not, CCT technology was already being used to measure toe (toe measurement is the difference in the distance between the front of the tires and the back of the tires) and camber (camber is the angle of the wheel when viewed from the front of the vehicle) on an industrial wheel alignment system.

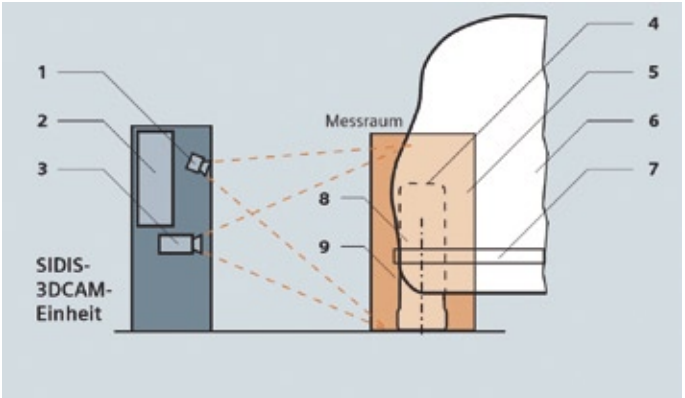
Trying to understand what CCT is all about, or even why anybody would have such a difficult time coming up with a non touch metrology system that could work, one has to understand that a wheel (rim or tire) is one of the most unusual objects for optical measuring. The lack of clear edges and clear contrasts makes it very difficult, even with modern technology, to calculate measurements without the additional help of reflector targets. In a CCT probe, an industrial grade projector beams an image of coloured stripes at a particular angle reflected onto the surface of the wheel. A single camera in each of the twin probes enables an image processor to make an analysis by identifying the size and shapes of the reflected coloured stripes whether they are on a wheel rim, a windshield of a sports car or even a woman's face. The bottom line is: CCT was already being used to measure wheel centres, toe, camber etc. of cars in industrial aligners.

Eagle for the Garage

Under normal circumstances, this would have been the end of the story because, whatever was working as an industrial end-of-line wheel alignment system, was considered as highly specialised (a one-fits-one instead of one-fits-all solution) and first and foremost unaffordable for the use in any car dealerships and independent workshops. We then had another surprise: the Siemens 'Probes' (they call them 'Sonden' in German) could already measure everything the corporate parking lot offered, including different sizes, ages and types of wheels.

The issue then arose as to how we could make industrial equipment affordable for the garage workshop. Yes, the probes are definitely very expensive but by combining them together with ATT's robot technology, which meant just having two instead of four, we had the key to a rather unusual symbiosis: the Cura R 2000, known as 'The Eagle'.

Once the car is driven onto the ramps, the system works out what model is expected, so that the correct specs are chosen from the databank. The measurement process starts, and while the probes find their way to the rear and front wheels, the operator can bide his time doing something else. The measurement process incorporates the described run out compensation on all wheels with automatic



Schematic overview of a probe: 1. Camera, 2. Embedded PC, 3. Industrial grade projector, 4. Tire, 5. Measurement area, 6. Undercarriage, 7. Axle, 8. Wheel, 9. Wheel coverage

The user is taken through the complete test with a large, clear and concise live measurement display

3-dimensional tire recognition on the basis of CCT-Technology

retrieval of values using the push and pull technique but with the vehicle safely staying in place on the lift in either first gear or in park mode if it's an automatic gearbox. The individual wheels rotate as a consequence of the integrated plates moving in opposite directions. They only use the freedom of movement allowed by the differential gear.

After about three minutes, the operator comes back, and the only thing left to do is the caster sweep. Even here, further innovation has been applied. The so-called 'micro sweep' is a totally unique way of measuring caster (caster is the angle of the steering pivot attached to the suspension system, when viewed from the side of the vehicle). It only takes a turn of the steering wheel just a quarter turn right-left and back to the centre. Everything that comes after, i.e. adjustment work, is done the same way as with conventional aligners. These include rear axle, tricky camber adjustments, and also even the 'S Point' on multilink axles. Besides the fact that some people might think otherwise, the system has full control over the symmetry axis, thrust axis and it can of course deal with cars that were not driven straight onto the ramps etc.

Support in success

The first Eagle has been in daily use in a large workshop for almost 2 years now, so the system is well past the phase of market introduction. Today, there are approximately 60 systems in use worldwide, increasing every week.

Inaugurated at the Tyres show 2008 in Essen, the Eagle now even 'speaks OBD'.

This allows automatic vehicle selection for those cars that follow the manufacturer's OBD (on board diagnostics) standard and put the Vehicle Identification Number (VIN) in the correct place. Not too many yet, but also increasing steadily. In order to make use of the extra investment until the right time, the OBD reader device can also double up as a secondary display to enable convenient adjustment. The Eagle has a 'Wingman'.

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Effort Not Wasted

Camera Surveillance Puts a Stop to Illegal Waste Disposal

An innovative measure developed by Dallmeier, in cooperation with the Somerset County Council in Great Britain, is meant to put a stop to the illegal disposal of trade waste. To that end, all waste disposal sites operated by the company Viridor Waste Management are equipped with a surveillance system that automatically analyses recorded registration plates. Thereby, tradespersons who are illegally dumping their waste at sites reserved for household waste in order to avoid disposal charges, can now be identified.

Viridor operates nationwide, offering an extensive range of waste and recycling services. It has 18 civic amenity sites in Somerset, which are operated as part of a contract with the council. All the sites have been successfully covered by CCTV for more than two years, but concern about illegal disposal of trade waste prompted the introduction of automatic number plate recognition (NPR) so that repeat offenders can be identified and stopped. The NPR system is now being rolled out to all 18 sites so that traders cannot evade detection anywhere in the county.

A Nationwide Problem

Householders are entitled to free disposal of their waste, while traders are obliged by law to pay for the disposal of commercial waste such as that arising from building work. Some companies attempt to avoid payment by pretending that their waste is domestic in origin. In consequence, a substantial amount of trade waste finds its way into household waste disposal sites nationwide. "By going down this technology route, we can try and stop it," says Viridor Contract Manager Brian Nicholls, who is responsible for public sector projects. No-one knows what percentage of the waste at council civic amenity sites is being disposed of illegally. However, using the new Dallmeier system, Viridor has already identified some vehicles that are visiting its Somerset sites unusually often – sometimes more than sixty times a month. Of course there are frequent users who do have fully legitimate reasons for stopping by so frequently. "We have some people who call in every week to deliver their bottles," says Mr Nicholls. "That group of customers usually arrives by car though and not in vans, which is why we can exclude those people from our list of possible suspects."

Councils and ultimately taxpayers have to pay the bill for haulage and landfill charges of the extra materials and there are considerable savings to be made in clamping down. But it is not just a question of economics. "We do not hold a licence for trade waste. It is illegal for us to take it," points out Mr Nicholls.

An Elaborate System

In order to identify suspicious vehicles, Dallmeier has developed an elaborate system. The Dallmeier system automatically takes pictures of all cars and vans entering the civic amenity sites and records their registration numbers.

Dallmeier Cam_inPIX cameras keep an eye on everything

The waste is segregated on-site

Both, DF3000A-DN Cam_inPIX and DDF3000AV-DN Cam_inPIX are used at the waste disposal site

Using a newly developed software application by Dallmeier – the so-called Frequent Tipper Application – it is possible to record the frequency of vehicles entering the disposal site. Since the data are always recorded together with a picture, it is easily possible to determine whether an individual vehicle is a car or a van. Streamlined extraction and analysis of the recorded information from all sites allow for the identification of usage patterns through data collation.

A combination of Dallmeier software and hardware, all supplied by Norbain, provides Viridor and Somerset County Council with both a high quality general CCTV system and the specialist tools for recording and analysing the vehicles. The sites use digital Dallmeier harddisk recorders and DI-Detector NPR units as well as DF3000A-DN and DDF3000AV-DN Cam_inPIX cameras. Control and management of the CCTV systems is by Dallmeier's easy-to-use PView and PGuard software, while the NPR uses the Dallmeier DI-CAPE (Central Application for Pattern Evaluation) management software and the new data extraction system.

Building on Success

Prior to the introduction of the tailored NPR (number plate recognition) system, the general CCTV system had already been running successfully for two years. Originally, CCTV technology had primarily been used for health and safety reasons as accidents can happen on the busy sites and in case of an emergency the recordings are useful in reconstructing exactly what happened. Some specific sites also have an insurance requirement for CCTV and alarms.

Mr Nicholls had carried out thorough research before choosing Dallmeier. When the issue of implementing a number plate recognition system for Viridor arose, his previous experiences spoke for Dallmeier. Not only was he impressed by the good business relationship itself but also by the fact that all the development work for the advanced system would be done in-house. Therefore he could rest assured that the final system would fulfil all his requirements.

Close Cooperation

Dallmeier has worked closely with Mr Nicholls in developing the frequent tipper software application mentioned above. The software is brand new and the requirements were developed from scratch to ensure that it met both the county's and Viridor's demands as well as being more generally applicable to other councils and operators. Mr Nicholls has already hosted visits from several other councils and waste management companies that were keen to see the system in operation.

Installation was carried out by Perspective CCTV. The company has also assumed out-of-hours security monitoring which is carried out from its new centre in Essex. Implementation of the networking has also been an important aspect. Keyfort, a company specialising in network technology, set up a virtual private network system that provides the real-time data used by Viridor as well as Somerset County Council.

"The system has already proven to be highly user-friendly and it works very well," says Mr Nicholls. The enormous potential for reducing the amount of waste is already becoming clear. The technology can also spare Viridor's staff from the dangers of potentially confrontational situations. People who are suspected of dumping trade waste sometimes become hostile, but staff members are now secure in the knowledge that all events are recorded and any incident can be followed up.

Emerging Applications

Further applications of the CCTV recordings and NPR data have also emerged now that such extensive information is available. One of the management tools in the NPR system is a graph showing the busy periods. Mid-morning might be the busiest time at one site, and the quietest at another. "I will be able to arrange for people to help out at other sites at the busy times once I have sufficient data," says Mr Nicholls.

Having CCTV provides further managerial benefits too, such as allowing instant confirmation of when skips are ready for emptying. "We can then prioritise trucks to the right sites instead of picking up a skip that is only half full," he adds.

The costs of the system will be recouped from a combination of gains in several areas, says Mr Nicholls. "The investment pays for itself through the reduction in trade waste, health and safety improvements and rationalisations in the operational business. In all of these areas the use of the CCTV and NPR systems offers significant benefits."

For these cans there is a life after the container – they'll be recycled

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Caught Speeding?

Creating Safer Roads with Machine Vision Technology

Police forces have been using speed measuring devices for several decades and huge technological advances have been made since the original concept was developed. Constantly expanding infrastructure means that automated speed enforcement has become a prevalent part of society and a valuable aid for the police. Unattended systems leave police forces to concentrate on other issues.

Although public opinion about speed cameras is still divided, many areas have seen drastic improvements regarding the number of people seriously injured or even killed as a result of speeding.

Next-generation Speed Enforcement

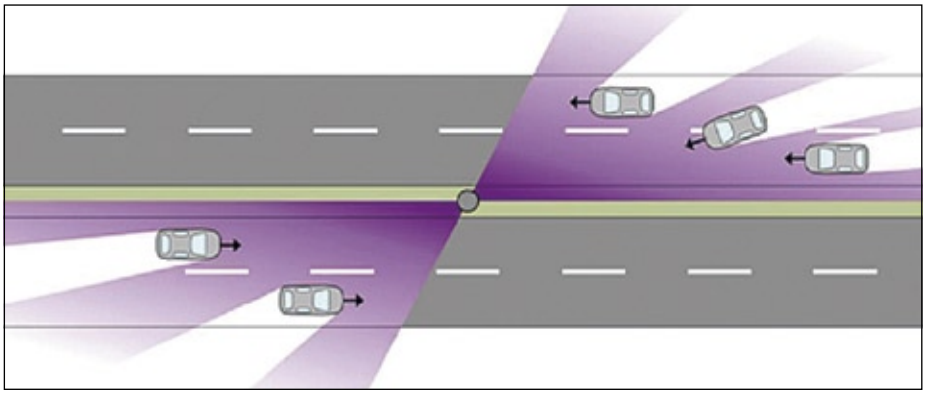
Laser technology is a relatively recent introduction into the area of speed enforcement. With the help of machine vision technology, Vitronic has increased the efficiency and reliability of speed measuring devices.

As an alternative solution, PoliScan^{speed} uses LIDAR (Light Detection and Ranging) technology in conjunction with digital imaging to provide police forces with the most advanced law enforcement equipment available. Laser systems send a 'fan' of beams across the entire road which can simultaneously measure the speed of multiple vehicles across multiple lanes, regardless of the direction of travel. Traditional, RADAR (Radio Detection and Ranging) systems are able to measure the on-the-spot speed of a single vehicle. As a result, technologies such as these which provide analogue, wet-film photographs are now considered to be outdated.

Increasing the Number of Valid Reads

To ensure an accurate measurement, the core of the PoliScan^{speed} system consists of an eye-safe scanning LIDAR unit which is mounted in a stationary position and transmits short pulses of light out to a target: the transmitted light is then reflected back. The time for the light to travel out to the target and back to the LIDAR sensor is used to determine the distance and angle to the object. These measurements are carried out with a high repetition rate of 100 transmissions per second, enabling a very precise measurement.

The results of the LIDAR scans are subsequently analyzed by an internal processing unit, measuring the speed of every vehicle in the surveillance area. Each vehicle is 'tracked' from a distance of between 75m and 15m from the speed system. A real-time overview of the traffic flow is constructed and if the average speed of a vehicle exceeds the speed limit, the processing unit activates the cameras and captures an image. The system from Vitronic makes use of two high dynamic range cameras and the laser-based design delays capturing the photo until the vehicle reaches the optimum distance for a clear, sharp image of



The LIDAR systems can measure multiple vehicles on up to 4 lanes of traffic in each direction

PoliScan^{speed} can be quickly mounted on a tripod without the need for on-site calibration

the license plate and the driver (if required). The twin-camera setup takes high quality photos of vehicles traveling across multiple lanes and, importantly for the authorities, reduces the size of the case files.

To enable 24 hour operation, illumination is provided by a specially adapted flash unit. Dependent upon requirements and local legislation this could be a xenon flash with a red filter or an invisible infra-red unit. The compact design enables mobile use on a tripod, portable use in the front or rear of a vehicle, and for roadside installation (pole-mounted). When a violation is detected all image-, measurement- and case data are brought together as a case file, stored in the system and are digitally encrypted.

From every case PoliScan^{speed} generates an evidence data file consisting of: the key information of the particular series of measurements (speed, time, location etc.), a case-related text part, a clear overview image including the license plate and a graphical template for evaluation. If mobile operation is conducted, a modified notebook with specially developed software allows the data to be read-out and analyzed by an authorized person on site. Alternatively, with a fixed roadside system multiple data download options are available: on-site via a laptop or a removable hard-disk or, in the case where a connection is available, via LAN or wireless-LAN. By using the back office system PoliScan^{office}, cases can be evaluated and processed.

LIDAR: meeting all Demands

With PoliScan^{speed}, Vitronic offers a next generation laser-based speed measurement system. In sharp contrast to older technologies, the new device relies on a detection and tracking (DTU) principle, overcoming the many drawbacks of classic speed enforcement systems. By 'tracking' vehicles over a longer distance, the average speed of several vehicles can be measured simultaneously, regardless of whether they are traveling parallel, tailgating or even overtaking. If a vehicle traveling within a group is violating the speed limit, this can be singled out. The system is even capable of stating in which lane the vehicle was traveling. Up to four lanes can be monitored from a single system at a broad choice of challenging sites including curves, tunnels, construction zones and dense city areas, at speeds of up to 250km/h (155mph). Interference from objects such as walls, barriers, signposts or pedestrians is discarded. No in-road equipment, such as piezo sensors, or road markings are required.

PoliScan^{speed} is certified for unattended use and already has State Certification in multiple European Union member states and Australia. The system is

PoliScan^{speed} system with a fixed city housing contains rotatable segments

The dual-use housing permits both fixed and mobile speed enforcement

capable of detecting vehicles from both the front and the rear and can also distinguish between cars and trucks, for when differential speed limits apply. When combined with the back office software PoliScan^{office} it provides a fully integrated enforcement system providing a 'digital processing chain', including Automated License Plate Recognition (ALPR).

International Solution

Each PoliScan^{speed} system can be customized to meet local demands. Color cameras can be installed in countries where the style and design of license plates can change, for example, in the United Arab Emirates. For countries with a harsh climate, and to protect the components when the system is to be used as a fixed roadside installation, a number of housings are available. Each of these offers additional protection from bad weather and vandalism, and is carefully designed to fit into an urban environment or by the side of a high-speed road. A 'city' pole consisting of rotatable segments for installation on the hard-shoulder or median strip can monitor traffic traveling in one or both directions. Two systems are required to monitor in both directs on multi-lane roads and, as a result, up to eight lanes of traffic can be enforced from a single housing.

World's first Dual-use Housing

Alternatively, a second housing is now available. The 'dual-use' housing from Vitronic permits both fixed and mobile use. The unique design allows the whole system to be easily inserted into the fixed roadside housing. If required, it can be removed and mounted within a patrol vehicle or on a tripod, then reinstalled after mobile enforcement is complete. The equipment is mounted on to an internal metal wall and to provide additional protection the inner housing is surrounded by a second casing made out of steel plates. The outer steel housing also serves as a sun roof to prevent the inner housing from direct sunlight. With this option up to 3 lanes can be monitored in a single direction.

Both the 'city' and 'dual-use' housings are bullet proof and enable the system to operate in adverse temperatures.

The Intelligent Choice

Recent projects in Germany have proven the benefits of the most modern speed enforcement equipment. When the systems were installed in Stuttgart at the beginning of 2008, the number of prosecutions, which were valid before a court of law, jumped from around 70% with the previous system, to well over 90% with PoliScan. Other installations on prominent roads have resulted in over 600 cases of speeding drivers caught per day.

Technology Transfer

Vitronic has been an international producer of machine vision systems for almost a quarter of a century. The technology developed for the PoliScan^{speed} products has also been transferred to other areas, especially in relation to traffic enforcement. The laser technology forms part of PoliScan^{surveillance}, an ALPR system used by police forces to search for wanted or suspect vehicles.

Products belonging to the TollChecker family use lasers to provide intelligent automation solutions for all toll collection methods. Timely, accurate and reliable classification is at the core of all tolling systems. By leveraging the advanced 3D technology offered by Vitronic, toll systems operators can successfully detect, classify and monitor vehicles at variable speeds, even when only a part of a vehicle has passed the classification point.

Industrial automation is another area which has benefited from Vitronic technology. For maximum process reliability and efficiency, laser-based systems are capable of the three-dimensional analysis of components: from the positioning of gearboxes to the inspection of powder compacts and syringes. Weld-seams and surfaces can also be checked for faults.

Other areas where this technology is used include the identification of barcodes, codes and characters on packages, and the three-dimensional measuring of humans.

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Vision Profiling

Introduction on Forensic Science and Machine Vision

Forensic science has been a challenging field with major developments for several decades, and very popular due to TV shows such as CSI. It is a widespread field, which answers questions for the legal system. In this part we focus on forensic science in the criminal justice system. Automated databases of fingerprints have been in use for several decades now, and also DNA databases are very commonly being used. However which other databases can be used in this system, and what other challenges do appear in forensic science? One of the major issues is statistics and linking forensic evidence with a person and a crime. In this article a short overview is given of techniques and methods for machine vision in forensic science.

Cameras themselves can be identified by their pixel defects

If we look in forensic science there are many image databases that are of interest:

- biometric databases: fingerprints, ear prints and other latent marks (feet prints, lip prints etc), faces, DNA, iris, etc.
- databases of marks derived from objects: shoeprints, firearms, toolmarks, drugs/pills, camera images
- other databases: chemical composition of paint, glass, fibres, etc.
- and of course databases based on digital information, depending on the legal system in general or case-by-case: bank account information, phone records, location information from GSMs, email information, search information from search engines, and many more types of records

If we look into fingerprints, the Automated Fingerprint Identification Systems are well known for several decades. The largest known database, Integrated IAFS, is in the United States, which includes the biometrics of 55 million subjects. In the system fingerprint data is available from persons and latent prints of crime scenes with various quality. A fingerprint can be compared with the database and will return a ranking list of candidates fingerprints. Depending on the quality of the prints (latent prints from crime scene are often of lesser quality compared to prints taken from a person), a ranking list will be returned. If ten-prints are compared a higher confidence is possible. An old for classifying fingerprints manually is the Henry Classification scheme. This classification system dates back to the early 1900s, when fingerprints were classified manually, however it is not used in present day.

Three approaches are used in commercial automatic fingerprint systems: syntactic, neural network and statistics

Matching Fingerprints

Three approaches have been used in commercial automatic fingerprint systems (often in combination):

1. Syntactic: the ridge patterns and minutiae are approximated as a string of primitives. When a new pattern arrives, the string of primitives is formed and passed to a parser whose output yields the class of the input pattern. It is also possible to extract features based on minutiae and then present the features using a graph data structure. Exploiting the topology of features provides structural matching.
2. Neural network: the feature vector is constructed and classified by a neural network. Several types of feature vectors and neural networks have been used.
3. Statistical: the feature vector is constructed and classified by a statistical approach. Two approaches have been developed for the process of measuring the similarity of classified fingerprints: point matching and structural matching. In point matching, two sets of minutiae code are aligned using their locations. In addition, the sum of the similarities between the overlapping minutiae is calculated. The similarity between two minutiae is measured using the attributes of the minutiae. In structural matching, a graph is constructed for each fingerprint that codes the relative locations of minutiae. As a similarity measure, these graphs are compared for two fingerprints.

A problem confronting fingerprint matching is the lack of reliable algorithms for ex-

tracting minutiae. Existing algorithms result in spurious minutiae because of an inability to cope with anomalies introduced by factors such as scars, over-inking, and sweat. For this reason human intervention is generally needed after application of these algorithms in order to check that the fingerprint classification is correct.

Toolmarks

For toolmarks, for instance from screwdrivers, in the past methods have been developed to do automatic comparison. Screwdrivers are often used in burglaries, and striation marks can be formed with them. By making test striation marks with the screwdriver, one can fill a database with striation marks and impression marks. The striation marks should be compared with the same lighting conditions. In theory reading 3-dimensional images would be optimal, however since it is expensive and time consuming at the moment, this is not yet widely done. The automatic systems are immature.

Shoeprints

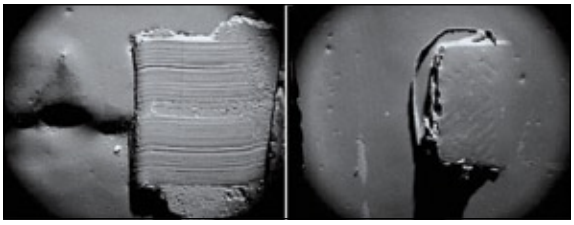
There were several efforts for shoeprints and automatic comparison, however until now they are not used in practice. Shoeprints can be valuable since they are often found at the scene of crime, and often suspects wear their shoes still. Since there might be characteristic marks from glass, stones and other damages on the outsoles, in a forensic laboratory one can link a shoeprint with a certain shoe. Also it is possible to have a reference database with shoes available from shops, in order to compare the shoe profile found at the crime scene and try to link it to a certain brand or type. One database which is known is Sicar.

Firearms

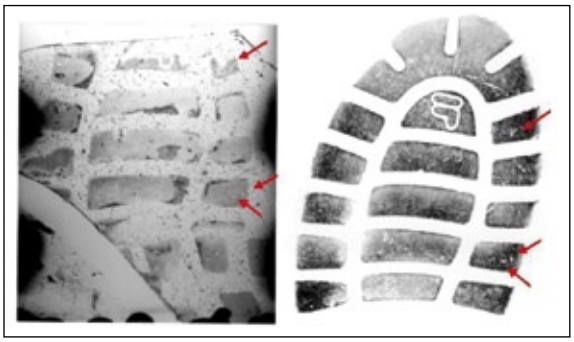
With firearms also identifications are possible, based on breechface marks of the cartridge case (partly caused by the firing pin) and by the striation marks on the bullets. Several systems are in research stadium, however there is a widely used system IBIS (www.forensictechnologyinc.com). This system works with a database of cartridge cases and bullets. Standardization in images is important to have a relevant ranking list of bullets and cartridge cases that are relevant. The algorithms of these systems are not publicly available.

Camera Identification

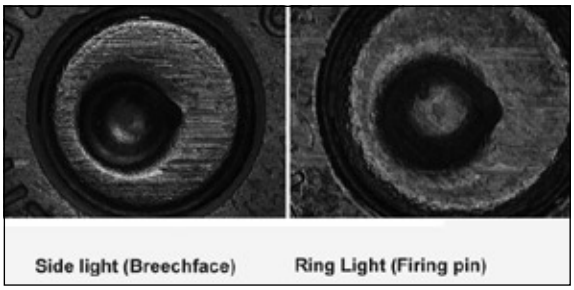
Image processing is a well known field in forensic science, what is less known is



Tools can be identified automatically by their striation marks



Comparison of a shoe mark from the crime scene (left) and a test shoe mark with a shoe of a suspect (right)



The IBIS system for fire arm identification works with a database of cartridge cases and bullets

that the cameras themselves can be identified. In the past research was available on pixel defects in a CCD/CMOS to identify a camera. Since sensors improve, these kinds of defects are often not seen anymore. There is a characteristic pattern in the sensor due to slight variations, which is called the Photo Response Non Uniformity (PRNU).

By taking many flat fielding images (images with the same intensity, preferably grey or white), the PRNU of the sensor can be determined. The real world images can be compared with these images. To filter out the PRNU, edges of the image have to be filtered out, and the image contents should be suitable for extracting this pattern (preferably homogenous areas in the image). An example of this software has been developed by the NFI in open source (https://sourceforge.net/projects/prnucompare/).

Linking Evidence and Solving Crimes Forensic Profiling

When linking different databases internationally, such as DNA databases, more hits will be found. Also when linking fingerprint databases to DNA databases crimes might be solved, which would not be solved in any other way. When upscaling these efforts to large profiling of different databases, it is expected that more crimes are solved, however the risk of false positives remains and one should be aware of these. To give an overview of these techniques and the legal implications, more information is available at D6.7c Forensic Profiling of the EU network of Excellence FIDIS (www.fidis.net).

Challenges for the Future

Perpetrators become more aware of the forensic evidence they leave, and will try to erase or change traces. However the variety of methods in forensic science is wide. It is expected that forensic evidence is more challenged in court, and that validation especially of subjective comparisons (such as toolmarks and firearms) or trying to making them more objective, will be a major effort for the next years.

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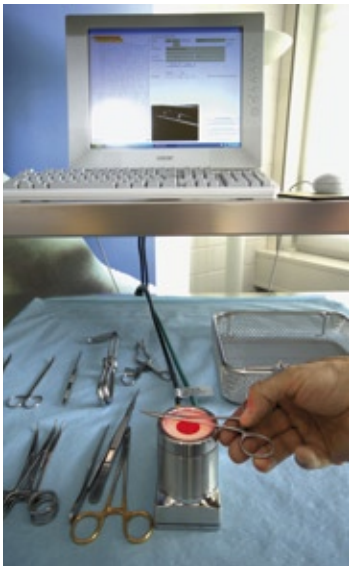
Traceability of Medical Instruments



Ulrich Swiss has developed the Kenus system using Cognex In-Sight 5400S vision systems where traceability and management of sterile surgical instruments are critical factors. The robust stainless steel housing allows the reader to be used in IP68-rated (NEMA 6P) sterile, hygiene-conscious environments. Each instrument is permanently marked with 2D Datamatrix code, just 0.8 x 1.6 mm and 100 % reliable, containing the extensive information necessary to keep track of it. The matrix code is drilled into a recessed surface on even the smallest of instruments, making the code damage resistant. The data management functions allow staff to identify how often an instrument has been sterilised and used.

Cognex Germany Inc.
Tel.: +49/772/6639-252 • sales@cognex.de • www.cognex.de

High-Resolution, High-Speed Sensing from Difficult Surfaces

The Selcom SLS5000 series of in-process non-contact sensors from LMI Technologies offers ultra high performance, even in hostile environments. Robust and with an extremely fast automatic light control circuit, this sensor measures on varying surfaces from matt topography to the shiny black materials of varying degrees of texture, colour and reflectivity often found in the tyre and rubber industries. It provides 16kHz data with real time control of laser intensity to provide accurate measurement data at a range of up to 1,250 mm and delivers resolutions down to 0.15 micron. The durability of the sensor housing allows usage in extreme temperature applications, such as thickness measurement of calendaring rubber at the extruder head. This provides users with a high performing sensor that can measure difficult target materials in hot and humid plant conditions.

LMI Technologies AB
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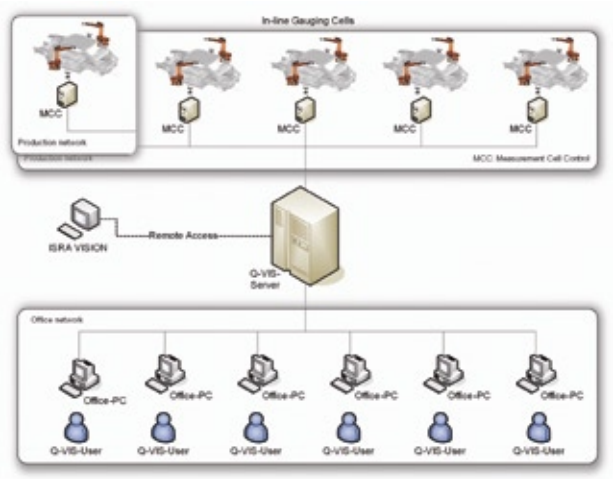
On-line, In-line Production Monitoring



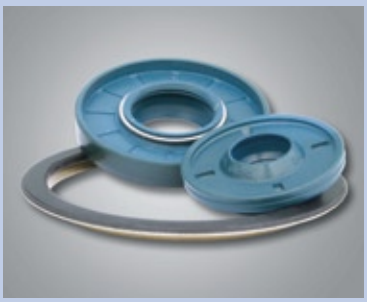
The full potential of in-line measurement technology is realized only when the accumulated data from individual stations are compiled to form an information base for comprehensive quality management of process measurement data. This helps to achieve a real understanding of processes and to avoid costs arising from defects, before waste is even produced. This task can be performed by the Production Quality Data Base Q-VIS from Isra Vision, installed on a central server separate from the sensor and robotic system, and used by an unlimited number of operators from their own office PCs.

Isra Vision AG
Tel.: +49/6151/948-0 • info@isravision.com • www.isravision.com

Tracing Glass Containers

On their common booth 13C89 at Glasstec, MSC & SGCC will be presenting the new Total Tracer device for complete traceability of glass containers. The device engraves, in the hot-end, a unique code that contains essential information for the whole product life: company, section and cavity numbers, production time-stamping etc. Positioned on the IS machine high speed conveyor, the encoded marking is automatically decoded in the cold-end. The tracer enables glassmakers to optimize their own production through more efficient quality management. The engraving is permanent and the information saved on the article allows unique product identification during the whole of the container's life: from glass plants, bottling plants, distributors and through to the final customer.

MSC Inspection Worldwide
Tel.: +33/437/2015-80 • customer.service@msc.fr • www.msc.fr



Machine Vision Tools

The surface of a seal is of critical importance for its functionality. It has to be free of any defects and the industry regulates an obligatory 100 % inspection of the parts. The requirements can be met during the production process by means of matrix and line scan camera systems that check every functional surface for defects. The test sample will be measured and the seal checked for the correct geometry (e.g. function angle, spring seat) by transmitted light. Surface defects can be detected via reflected light. Several projects have already been implemented by SAC, amongst others to inspect damper sealings, radial shaft seals, injection moulding parts, encoder rings and deflectors.

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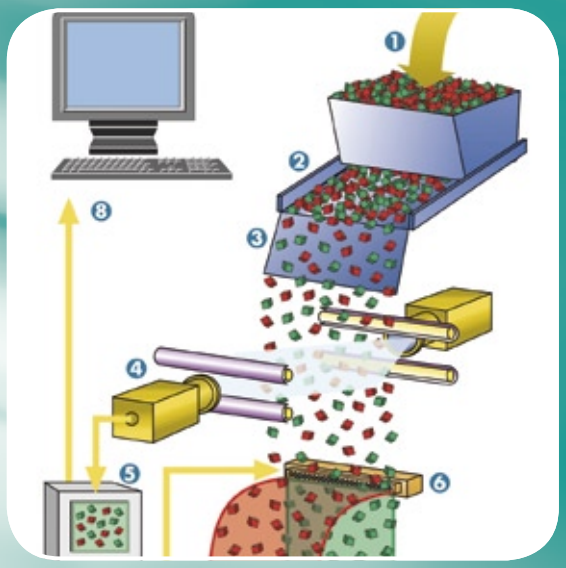
INSPECT

Control

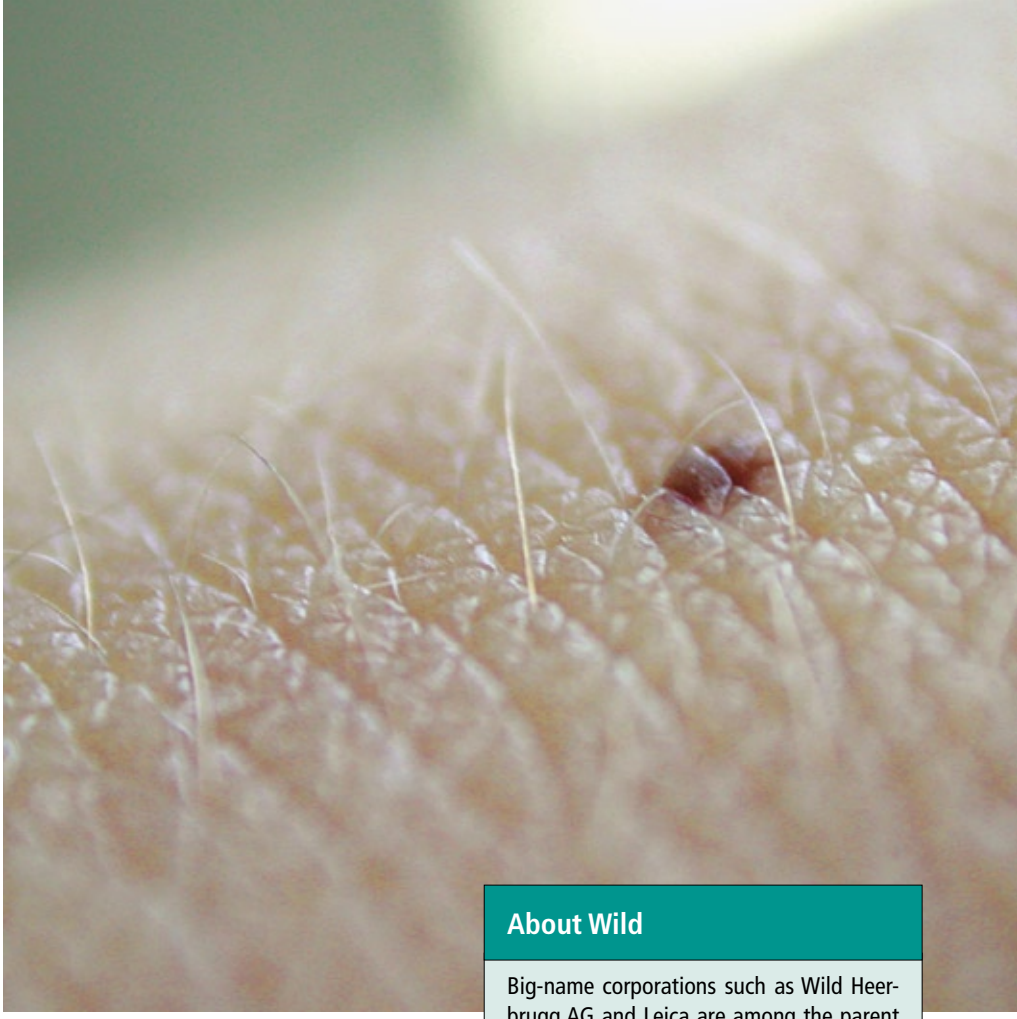


CONTROL: MATERIAL INSPECTION AND MEASURING INSTRUMENTS

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 food-stuffs, 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.

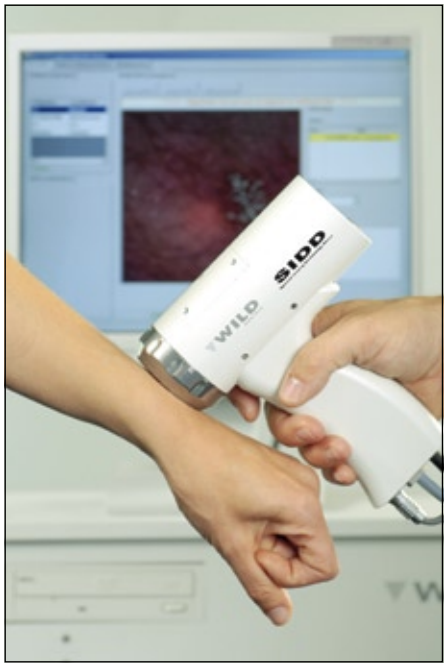
Life Saving Camera

Fast and Accurate Early Diagnosis of Skin Cancer



In Austria alone 2,000 people per year are diagnosed with malignant skin cancer. In 1983, 25 years ago, it was just 444 people per year. As the number of new cases is increasing drastically and although the chances of a complete recovery are very good when diagnosed early, worldwide more people are dying from melanoma than ever before. A unique innovation from Austria could now help to reverse this trend.

Wild GmbH with its head office in Völkermarkt, Carinthia together with Carinthian Tech Research have developed the highly sensitive S.I.D.D. camera, with which skin anomalies can be classified and diagnosed using a purely optical method. Differentiating between a benign mole and a malignant melanoma is possible through evaluation of a digital picture, without the mole having to be removed.



Within seconds the doctor can see on his screen if a melanoma is malignant

Advantages for Patient and Doctor

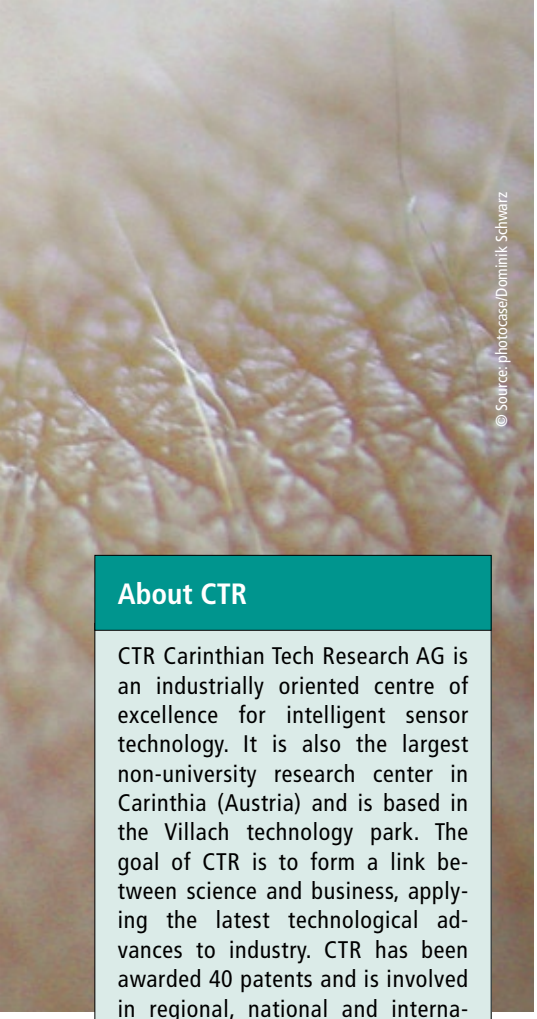
Compared to present systems the Wild camera provides a very significant result, instantly, without having to send a biopsy to the laboratory. Cells that are cancerous change and have a different metabolism than healthy ones. The camera detects this change and delivers a result within 10 seconds. The images enable an accurate early diagnosis to be made and raise the success rate of therapy considerably. The number of surgical operations can be reduced enormously. The digital pictures of the conspicuous area of skin are saved in digital form and are available at any time. When a patient presents for a preventive medical check-up of his/her moles, the last pictures of the lesion can be compared directly with the new ones, making it easier to judge whether a mole has changed over a given period of time.

"With the camera we developed in co-operation with CTR, a multi-spectral image with more than three colours is taken. On it details are identifiable which cannot be picked up by a conventional colour camera and are not visible to the human eye," is how Dr Arthur Primus, Head of Wild Medical Technology explains the innovative development.

Wild has brought 35 years of know-how in optomechatronics into this technology. Specialists in Völkermarkt have been working for around three years on this innovative medical technology. "A particular challenge was the hardware as it had to guarantee homogenous non-reflective lighting of the area of skin under examination. This consists of a source of light with an integrated industrial PC and a hand-held unit with an integral camera for photographing the area of skin under examination. The light emit-

About Wild

Big-name corporations such as Wild Heerbrugg AG and Leica are among the parent companies of Wild GmbH, which has been a separate enterprise since 1995. The key competency of Wild is the field of optomechatronics – from the idea to the finished product. The globally operating high-tech company has been active in research and production of systems and assemblies for medical technology, the aerospace industry, optical technology and the semiconductor industry for over 35 years.
Leading companies across the globe rely on the unique know-how from Austria. Wild is valued as an internationally recognised system provider and production operation for complete sets of equipment in medical and optical technology. Regardless of whether the products are surgical microscopes, ophthalmoscopes, digital photogrammetric systems or laboratory equipment, they set themselves apart thanks to innovative developments, optimal production processes with the best price/performance ratio and high quality standards (certified to EN 13485 and 9100). Based in Völkermarkt, Carinthia, Wild employs a staff of approximately 280.



About CTR

CTR Carinthian Tech Research AG is an industrially oriented centre of excellence for intelligent sensor technology. It is also the largest non-university research center in Carinthia (Austria) and is based in the Villach technology park. The goal of CTR is to form a link between science and business, applying the latest technological advances to industry. CTR has been awarded 40 patents and is involved in regional, national and international research projects. Among the investigation on assignments customers e.g. rank the Fraunhofer society, Infineon, NASA, Omya, RHI or Wild. Established in 1997 as the first Austrian based, non-university centre of excellence, CTR is also certified according to ISO 9001/2000.
www.ctr.at

ted from the light source is led via an optical fibre to the camera which is placed on the skin," explained Dr Peter Reiter, the S.I.D.D. project leader.

With this innovative camera details are identifiable that cannot be picked up by a conventional colour camera and that are invisible to the human eye

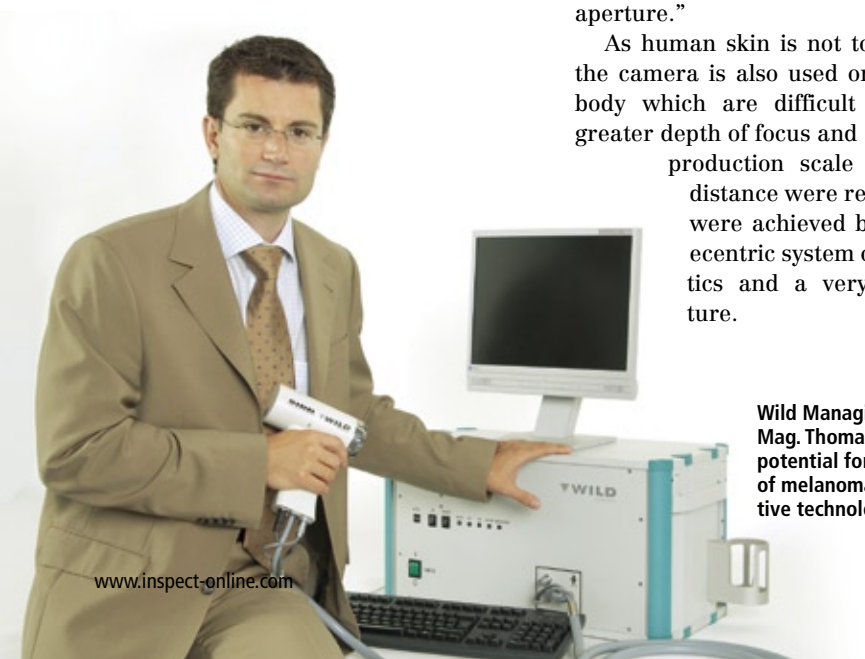
Efficient Coaxial Lighting

A major problem in the development was that the lighting of the skin area under examination and the image acquisition had to be carried out over the same optical path. In order to prevent dust penetration, a front cover, which must be easy to remove for disinfecting, is necessary. This front cover, however, can cause reflection in combination with the lighting. The classical solution would be to attach the light sources laterally and light with grazing incidence. However, due to the relatively low output light source, this was not possible, as the lighting time and thus the time required to capture the image would be too long," said Dr Arthur Primus. "So we developed special coaxial lighting, which is very efficient and allows short lighting times despite a small aperture."

As human skin is not totally flat and the camera is also used on parts of the body which are difficult to access, a greater depth of focus and a constant reproduction scale at a defined distance were required. These were achieved by using a telecentric system of imaging optics and a very small aperture.

Patent pending

Wild Managing Director Mag. Thomas Jost sees great potential in this innovative technology for early diagnosis of melanoma. "The product is ready to go into production. We have applied for a patent on the basic technology. At present we are looking for a suitable sales partner who can establish this product using their own strong brand name. To date three clinical trials at the university hospitals in Graz and Vienna have shown very good results. The objective is for tests carried out with the S.I.D.D. camera to become part of routine preventive medical check-ups."



Wild Managing Director Mag. Thomas Jost sees great potential for early diagnosis of melanoma in this innovative technology

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What makes for a good airport experience? Whatever the answers, they are unlikely to include the prospect of long check-in and security queues or the inconvenience of pat-down searches triggered by boot zippers or bras. And, of course, removing belts and shoes make for an even more cumbersome and time consuming process for passengers and staff alike.

Have a Safe Flight!

Improved Security and Efficiency for Airport Passenger Screening

Though the carry-on baggage screening process is being revolutionised by automated and self-service technologies, the reality is that the security burden is constantly increasing. As we are unlikely to see a reduction in the threat level posed to air travel in the foreseeable future, we must turn to advances in technology to help smooth our passage through the security channel. The positive message is that there are a number of significant developments that promise better performance and increased efficiency when it comes to clearing security not only for baggage but also for passengers themselves.

As we all know, the checkpoint security procedure has two main objectives: the screening of passengers and of their carry-on bags. For both of these areas, new technologies promise to address the extra requirements that have been driven by events in the recent past. Looking at screening activity, we find it standardised by regulation which generally involves a uniform configuration of carry-on baggage and people screening equipment with their associated procedures. Throughput performance of this configuration, however, can vary significantly. Following recent advances in automatic liquid and explosives detection equipment, such as the worldwide deployed Smiths Detection Hi-Scan 6040aTiX, there is now on the horizon a second generation of people-screening devices that could change the security sector dramatically.

Smiths Detection's innovative millimetre-wave approach automatically detects concealed threat objects hidden under layers of clothing

A privacy filter works with the automatic detection software to identify the concealed object without displaying body images

Sentinel does Away with Pat-down Searches

Until now, passenger screening has comprised of a combination of metal detection and pat-down search. The procedure has worked well in combating threats that were historically important in airplane hijacking incidents. As the threat profile has changed, so has the need to raise the capability in the screening of passengers.

Metal detection portals have a number of inherent limitations. They neither detect non-metallic threats such as ceramic knives nor alarm at liquid or explosive threats. All of these potentially dangerous devices have to be detected by time-consuming manual body searches. In addition to metal detection portals, which play a vital role alongside other technologies, there are other techniques that allow the reliable detection of a large variety of non-metallic threats. Several known or brand new technologies that detect concealed objects are already deployed or are to be tested in selected airports as a means of providing rapid and effective people screening to identify objects – both metallic and non-metallic. Thus, along with modern carry-on inspection systems, a second generation of people screening equipment is also emerging.

Equipment especially geared to detect chiefly explosives, IMS-based so-called trace detection portals such as the walk-through Sentinel II from Smiths Detection, already exists. The Sentinel II is widely deployed at airports, high-profile government buildings, customs checkpoints, nuclear facilities, prisons and court houses in the United States. Continuously tested and reviewed, improvements are based on real-life environ-

ments and the evolving needs of security screening checkpoints.

Smiths Detection, highly conscious of the balance between performance and ease of installation in airports and other points of critical infrastructure, made the Sentinel II more compact to minimize space and cut maintenance requirements to reduce overall costs for the customer. In addition to a smaller overall footprint, the latest integrated version of Sentinel II continues to employ ultra-precise sample collection which enables greatly enhanced explosives detection screening in airports such as New York JFK, Baltimore-Washington, Reagan and Dulles.

Millimetre Waves vs. X-rays for People Screening

Ionizing radiation equipment, often referred to as backscatter technology, is another technology being tested in places. Widespread deployment in the highly competitive mass transportation sector remains doubtful as few people would welcome the idea of being X-rayed for every flight or for every entry into security sensitive areas. As long as there are less controversial and less potentially health-impairing technologies, most passengers will prefer a careful pat-down search over a detailed X-ray image exposing their body outlines. Aside from backscatter screening solutions, there is also transmission X-ray equipment available, albeit for a totally different and limited application. The advantages of transmission X-ray can be found at the likes of specific customs checkpoints, where drug swallowers are a known problem or at penitentiaries. These environments permit a strictly controlled use of that technology, which is clearly inappropriate for the mass screening of regular air travelers.

In the long run, passive or active millimetre wave systems could prove the best solution. Millimetre-wave provides imagery that reveals objects hidden under clothing. An example of passive millimetre wave technology is Smiths Detection's Tadar imaging system, which currently requires operator assessment of the images as they are produced. However, this is now being supplemented with assist and automatic functions in which the software pinpoints suspicious items on the body. The need to display realistic images – with the consequent privacy implications – will disappear as silhouette representations or even standard video images of the passenger can be presented to the operator with the software highlighting only the position of any concealed objects. An added benefit of this automatic system is the ability of the software to distinguish between organic and inorganic objects and to indicate the material characteristic of any suspicious item on the user display.

Over the past few years, security checkpoint processes have been forced to adapt to significant increases in inspection requirements. The resulting rise in workload and procedures for the operators has greatly added to inconvenience for passengers. Security equipment manufacturers like Smiths Detection are now responding to the new challenges – through both improved detection methods and enhanced operational approaches. Further advances in people screening technology – be it detection methods such as shoe screening or integration of sensors and processes – will continue to bring benefits to airport operators and passenger alike.

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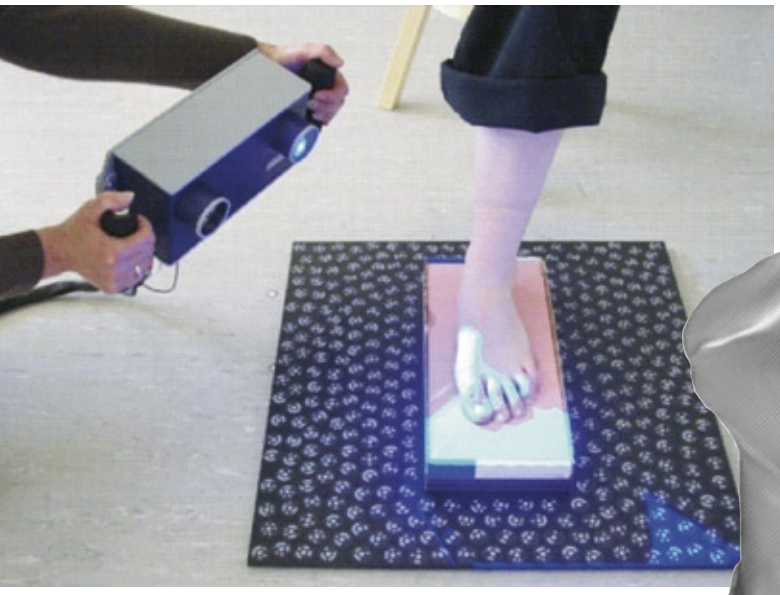
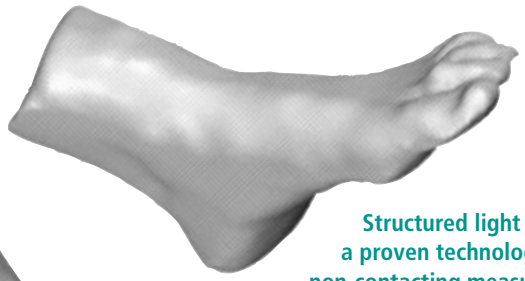
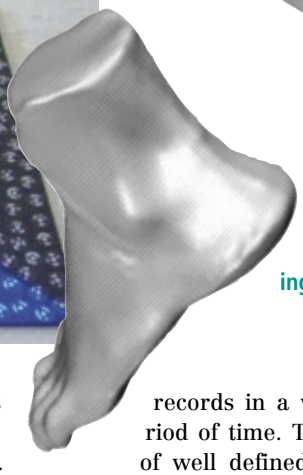
3D Snap Shots in Milliseconds

Body Part Scanning – Mobile, Robust and Fast







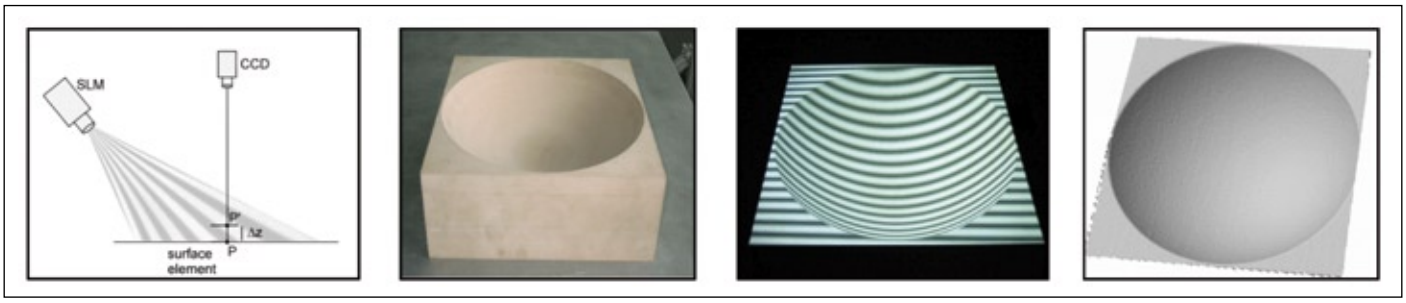
Structured light projection is a proven technology for the non-contacting measurement of three-dimensional shape. There are requests from medicine, security, and machine vision calling for 3D shape scanners that are mobile, robust, and fast. Reliable hand-held operation is one of the most challenging desires in this field.

The simultaneous 3D detection of all object points in the camera field of view is achieved by projecting structured patterns and creating stereoscopic pairs of points in camera and projector, respectively. The projection of only one static pattern may work in selected cases but is not at all sufficient for general use. Common approaches rely on the evaluation of multiple camera images taken with different projected patterns. Typically 6 to 10 patterns are used for one 3D measurement at minimum and up to 50 patterns are beneficial for improved accuracy and resolution. In other words: the 3D snapshot of a scene requires a sequence of structured light projections and synchronized camera records in a very short period of time. The generation of well defined precise light intensity profiles is another request that enables high speed without compromising resolution.

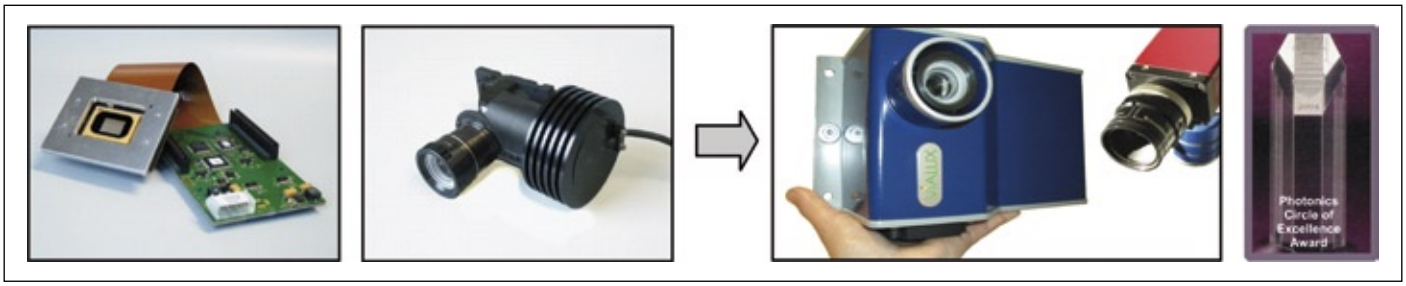
DLP Based 3D Camera

The DLP (Digital Light Processing) technology is unique in serving as the spatial light modulator that meets the requirements of structured light applications. DLP Catalogue products enable custom solutions for the direct control of the digital micro mirror device (DMD). The DLP Discovery platform proved well suited for 3D scanner design; it provides

- more than 10kHz switching rate for the full DMD



3D shape measurement by structured light full-field triangulation
left: scheme and 3D object, middle: camera picture with projected fringes, right: rendered view of the scanned 3D shape



Core components for the z-Snapper 3D camera: custom DLP Discovery DMD board and LED light engine (left), corresponding z-Snapper device with camera (right)

array and therefore at high resolution
- global DMD reset operation for exact triggering with camera exposure
- precisely linear output by digital pulse-width modulation (PWM) control of the intensity in each single pixel

A DLP Discovery based solution is implemented in the z-Snapper Vialux scanners by a USB controlled DLP Discovery Board for the 0.7 XGA DMD (1024x768 mirrors). Advanced LED light sources emitting high power at 460 nm are combined with suited CCD detectors giving an optimized design that was awarded with the Photonics Circle of Excellence Award in 2004. The DLP controller interfaces via USB 2.0 and the digital camera plugs into an IEEE1394b (FireWire) port so that the z-Snapper connects to standard laptop computers yielding a high degree of mobility together with the battery option. The z-Snapper captures 300,000 (x,y,z) coordinates of the object surface in just 40 ms and can even double the speed for 76,000 coordinates per 3D snapshot. The concept is extended to 4D by recording 3D shape sequences in time. Main fields of application are both medical and industrial inspection.

ScanStation3D: instant capture of full-360° shape

Rapid Body Part Scanning

Using z-Snapper as the core sensor unit, Vialux provides scanners suites for the acquisition of 3D body part shape with unparalleled speed. The 3D data are captured as convenient as pictures are taken with digital cameras and even 3D video functions are implemented. The devices are easy to operate and the recording process is fully automated. Eye safety is guaranteed by a laser-free design. An additional feature is the instant automatic alignment of 3D point clouds taken from different perspective views.

Two devices are tailored to the needs in the medical field: the compact, hand-held MobilCam3D and the ScanStation3D providing full-360° shape data by one single shot. DynaScan4D is an extension for the recording of 3D video sequences from persons in motion.

Using the MobilCam3D for foot measurement, e.g. the person puts the foot into the foam box and the operator takes 4–5 hand-held 3D camera snapshots per foot and all point clouds are aligned automatically by means of the target plate around the foot. Two additional shots of the foam imprint give access to the lower part of the foot.

For the ScanStation3D up to four 3D camera sensors are mounted on a suited frame in order to take the complete shape of heads, arms etc. All sensors work simultaneously and are well synchronized to avoid cross-talk effects. The whole measurement process is completed after only 0.03 seconds so that the object does not need to be fixed.

Advanced Machine Vision Applications

The 3D camera has been designed for use as a component and it fits smoothly into custom applications. Two software packages are supplied with the device, the z-Snapper program for instant use as a scanner and the SDK, a C++ API (DLL) for integrating the device into a customer's application. The use is widely spread and covers dimensional inspection as well as 3D data acquisition for industrial automation.

Comment: DLP is a trademark of Texas Instruments Inc.

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The Glass Cycle

Optical Sorting Enables High Quality Glass Recycling

For a very long time, glass was difficult to make, and so it was mostly used in luxury items and weighed against in gold. Today, glass is an everyday commodity, without which our lives would be difficult to imagine, unless you can picture a life without window panes, light bulbs, mirrors, televisions, bottles or binoculars, etc. A high quantity of these products are produced from recycled old glass. Optical sorting provides for the high quality the consumer expects.

In Europe, recycling of glass packaging is one of the most successful initiatives for protecting resources and the environment. In some European countries up to 85% of glass packaging is processed into new bottles and jars. Everyone profits from glass recycling – the consumer, the manufacturer, and naturally the environment. Manufactured from the ubiquitous raw material, sand, glass can be recycled as often as desired without a loss in quality. Mankind has been aware of the advantages offered by glass as a packaging for beverages for approximately 3,000 years. Reusing glass bottles puts a brake on more than just the growth of rubbish heaps. Melting down old glass also requires less energy than does the processing of the raw materials. With each ton of recycled glass the emission of greenhouse gases is reduced by 200 kilograms. Or expressed in different terms: if only 10% of the produced quantity of glass is comprised of secondary raw material, then emission of greenhouse gases is reduced by 5%.

Just how much emission the glass industry saves daily by recycling glass can be easily calculated given the fact that up to 90% of modern glass bottles are produced from old glass. In this process the quality of the end product remains at a consistently high level.

Striving for Purity

To keep energy savings as high as possible when using recycling cullet in glassworks, interfering substances, such as ceramics, stone, or porcelain (CSP), which must be melted down at much higher temperatures, should not exceed fixed limit values. Currently this CSP proportion should only be 25 g/t, and in the future this proportion should be reduced to under 10 g/t. Metals from seals and aluminum foil on bottles and champagne bottles are also subject to very strict requirements, and for some time now should only be contained at a maximum of 5 g/t. (Fig. 1).

All of these foreign substances must be removed from the glass in processes that demand a high level of technical effort. In addition this effort clearly increases if the color purity of the old glass cullet must reach a specific level. For example for flint glass, recycling glass purity above 99.7% is required.

Recycling companies strive to treat their previously collected old glass with a process that is as effective and cost-efficient as possible. The central elements of such plants are for example color sorting machines such as the MikroSort series from Mogensen GmbH. Currently approximately 270 Mogensen sorting machines are in use worldwide, of which approximately 180 are used to treat glass.

Opto-electronic Sorting in the Glass Processing Industry

To recover high-quality products from collected glass for reuse in the glass industry, the optoelectronic sorting systems in glass recycling have to fulfil the following functions:

Product refining
Extraneous materials such as CSP, ferrous metals, non-ferrous metals (aluminium, copper, lead) must be removed from the collected glass. In this way, low-grade material can be processed to high-grade material.

Product separation:
Mixed value materials have to be cleanly separated from each other. Each material can then be used on its own and be traded at a higher price e.g. as saleable amber, flint and green cullet.

Internal recycling:
The reject streams in the sorting plants still contain high percentages of valuable glass. Compared to the input material, this material is contaminated with a much higher percentage of CSP and contains difficult-to-classify material (very dark glass, thick base pieces, bottlenecks,

Fig. 1: Interfering substances in old glass

pressed glass labels, thin pieces of ceramic, etc.). The rejected material from the previous sorting stages must be processed into saleable mixed glass and the reject rates have to be reduced to a minimum.

The sorting of the crushed collected glass is based on the following principle (Fig. 2):

The product to be sorted is fed (1) to the sorting machine on a vibrating conveyor (2) and "singled" on an inclined glass chute (3). The material stream now takes the form of a monolayer, which passes in freefall a line-scan camera (4) with color image processing, which is used to classify the particles by true color. With the introduction of new signal processor technology (5), it is possible to process 30 mill. measuring points/s. Far more than 10,000 objects per second are identified and evaluated. Parallel to color identification, an installed all-metal detector enables the detection of unwanted ferrous and non-ferrous metals from a particle size of around 0.6 mm. Just below color and metal detection, particles are selected by means of targeted compressed air impulses (6). The pass and the reject streams (7) are then discharged separately.

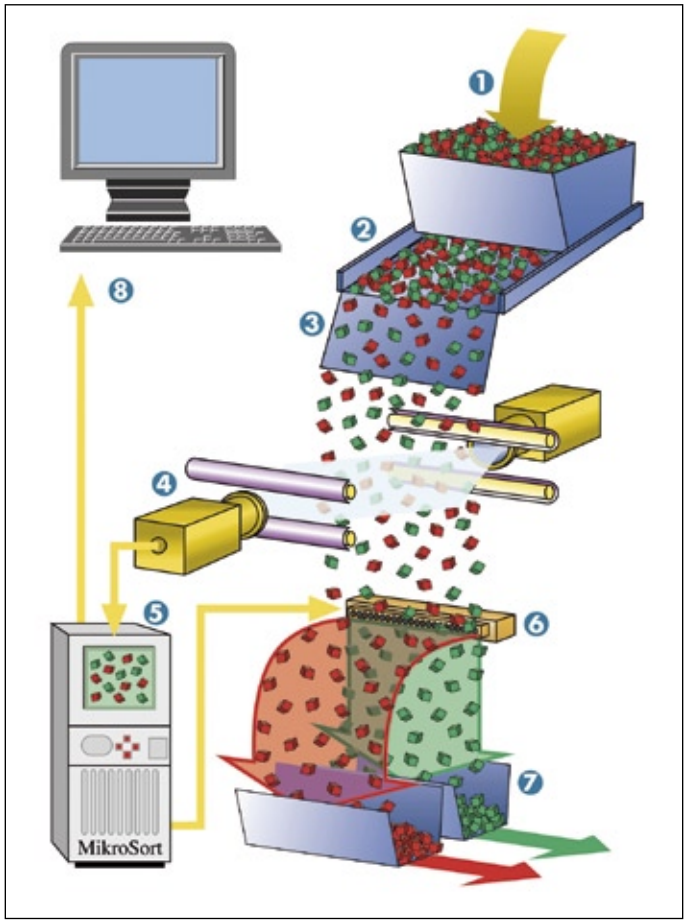

Fig. 2: Sorting diagram – Mogensen MikroSort

Depending on material, grain distribution and reject quantity, feed quantities from 3 to 20 t/h are sorted. The machines outsort up to 10,000 parts per second. Operational reliability is ensured even under the most demanding conditions.

Service and Maintenance Requirements

In most recycling plants there is little time for regular maintenance; consequently sorting quality decreases as contamination increases. This is why the entire lighting system is installed with a greater distance to the product stream, which significantly reduces contamination. Automatic

Fig. 3: MikroSort AX as transportable unit

Fig. 4: Mogensen SC1026 and the three downstream belts with the various grain sizes

Fig. 5: End product of the glass treatment plant on Gran Canaria

cleaning systems are installed at all contamination-relevant points of the MikroSort AX. In addition to the lamp these systems also keep the detection level and blow-out unit clean, even under unfavorable conditions. Generously dimensioned service openings on the sides also permit fast cleaning of the separating area of the machine in ongoing sorting operation.

Sorting Wet Glass

The MikroSort AX has been especially developed for sorting high reject quantities and highly contaminated recycling bottle glass grain size 5–60 mm, (Fig. 3) and can be used as an individual machine for special tasks as well as a unit within the total system. Thus with one machine, CSP, fine metal parts, from 0.6 mm in size and off-colors can be concurrently removed from the product stream. With the same machine at a different point, amber glass or flint glass is separated from a mixed stream and processed to an end product that can be sold. By networking individual MikroSort devices and given the possibility of storing a variety of programs per machine, extremely flexible implementation is ensured.

Local machine operation is executed via a simple, robust touch screen interface. All important machine data is clearly visible on the display, and the data can be adjusted by plant personnel via slider controllers as needed. Parallel data capture through a separate PC element enables monitoring of all relevant data and parameters, or monitoring of the running camera imaging from the control room.

Detecting Ceramics and Pastel Color Sorting

For plate glass treatment the feed material is usually clean and dry. In addition to CSP the sorting of extremely fine pastel colors is also a primary requirement. In this case with the Mogensen MikroSort AL an additional machine type for grain sizes 5–60 mm is available. Smaller grain sizes, like 1–5mm, are treated on the MikroSort AF, showing a higher resolution on a reduced working width. As opposed to the AX, the material is not detected in free fall, but rather material is detected directly on the feed slide. A lamp behind the slide enables complete and shadow-free illumination of cullet and thus precise differentiation of the most subtle color nuances. As glass ceramics have an extremely high proportion of these pastel tones in particular, with the MikroSort AL the Ceran proportion in plate glass is successfully and significantly reduced.

Sophisticated Screening Ensures Good Sorting Results

Precise classification of feed material is important for a good sorting result. Imprecise graining reduces the efficiency level of the sorting machines and most particularly increases the loss of valuable glass. Consequently the popular Mogensen SC long sizer was adapted for screening round glass. The feed area was fitted with reinforced wear protection, and changing of wear protection plates on the discharge hoods has been simplified. Through the use of special plastic screen mats and installation of a pneumatic screen cleaning system the machine works virtually without blockage – even with wet material and high organic charge.

Installation of this sizer in an existing system is facilitated by its compact exterior dimensions and comparatively low weight. It also works virtually maintenance-free in 3-shift operation; the simple change of screen surfaces – necessary approximately every 3–4 months – takes two people only abow 10 minutes per screen surface (Fig. 4).

A successful combination of multiple Mogensen sizers as well as 5 Mogensen MikroSort AX machines has been in use on the vacation island of Gran Canaria since 2007. At this site a total of approximately 15 t/h of wet mixed glass, metals, and CSP is cleaned and sorted into the individual colors (Fig. 5).

New Application Areas Thanks to X-ray Technology

Contamination of collected glass with glass ceramic from Ceran cooktops or fire-proof glassware is increasing on a constant basis. Glass ceramics have a melting point that is even higher than that of CSP, and significantly higher than the melting point for bottle glass. Because glass ceramics do not completely melt down even with small parts, in the glassworks tools are destroyed which causes extended downtimes, or bottles with defective points are produced, and this represents a safety risk particularly for champagne bottles. With normal optical process glass ceramics can no longer be differentiated from normal glass. The only exceptions are certain characteristic pastel tones that can still be detected in the visible spectrum and which can only be outsorted with a high loss of similar colored normal glass.

For this application Mogensen's solution approach is X-ray spectral analysis that permits an extremely precise detection of glass ceramics. With the MikroSort AQ a new, powerful and compact machine is available to glass processing plants that can also be easily integrated in existing sorting systems at throughput performance of up to 20 t/h.

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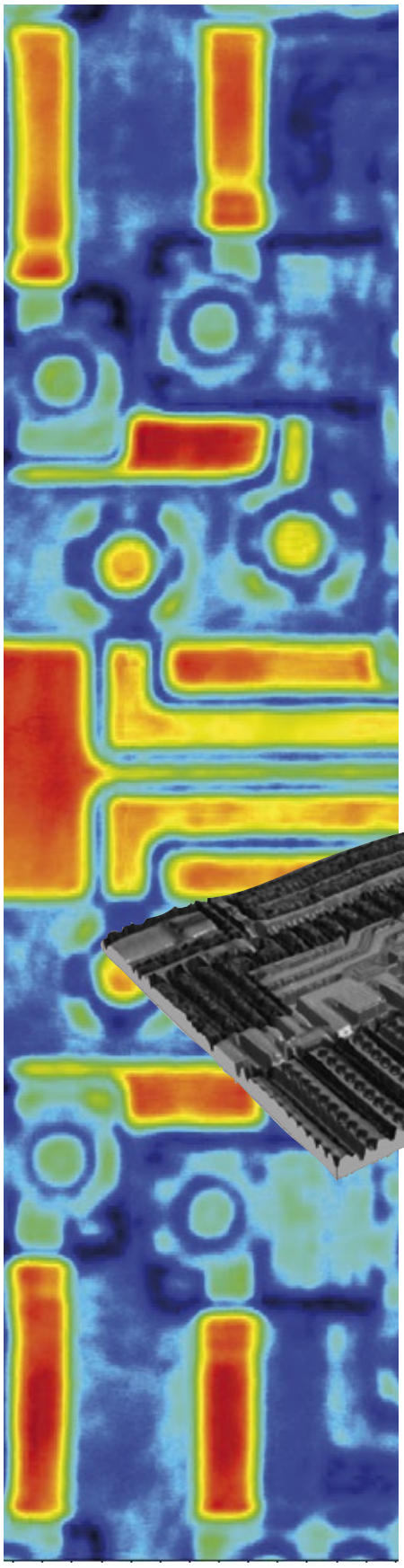
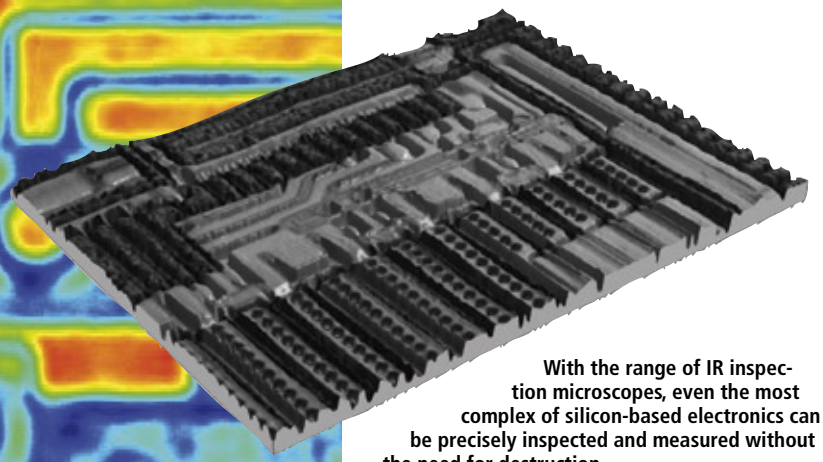
Seeing through Electronics, Optically!

Infrared Imaging Solutions Provide Inspection through Silicon



Silicon is amazing! It is the closest element to carbon in both composition and properties and is in fact carbon's natural chemical analogue. It is the second most abundant element (after oxygen) in the earth's crust making up nearly 26 % by mass. It is biologically essential, especially in the metabolic processes of plants, particularly grasses, and silicic acid (a type of silica) can be found as a major component in the protective shells of microscopic diatoms. Conversely, only trace amounts are required by animals. In the form of silica and silicates, silicon forms useful glasses, cements, and ceramics. Compound derivatives of silicon are also widely used in flexible waterproofing solutions or as an additive for lubricants.

Silicon's main use though, is in the semiconductor industry enabling the development of highly complex integrated circuits and even Micro-Electro-Mechanical Systems (MEMS). Many items now contain some sort of electronic circuit and the electronics industry is driven by miniaturisation requirements, meaning that more components are packed into smaller spaces. As result inspecting these tightly packed circuits is very difficult. Fortunately, silicon is virtually transparent to defined frequencies of light in the infrared region and therefore standard optical microscopes can be fitted with infrared illumination and used to inspect even the most complex of electronic components.



With the range of IR inspection microscopes, even the most complex of silicon-based electronics can be precisely inspected and measured without the need for destruction

Tightly Packed

Packaging technology of semiconductor devices is rapidly advancing, e.g. SIP (System in Package), 3-dimensional mounting, and CSP (Chip Scale Package), along with the increase in the need for thinner and smaller electronics devices. This makes observation for research or quality control almost impossible, with many components and even circuits packed into a tight space.

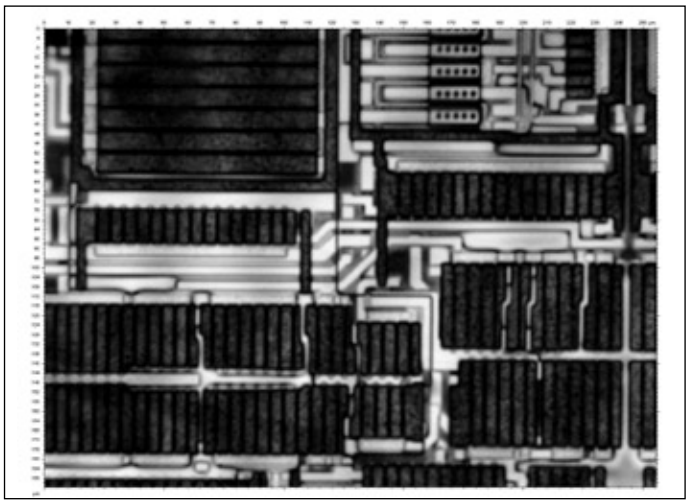
The new Olympus Lext-IR (OLS3000IR) is a confocal laser scanning microscope that uses a 1310 nm laser to literally see through the silicon to the components. Based on the highly successful metrology system – Lext-3D (OLS31000) – the Lext-IR is perfect for silicon device inspection, providing fast, efficient and as easy-to-use capabilities for ultra-fine subsurface resolution with SEM-like clarity for a wide range of imaging tasks:

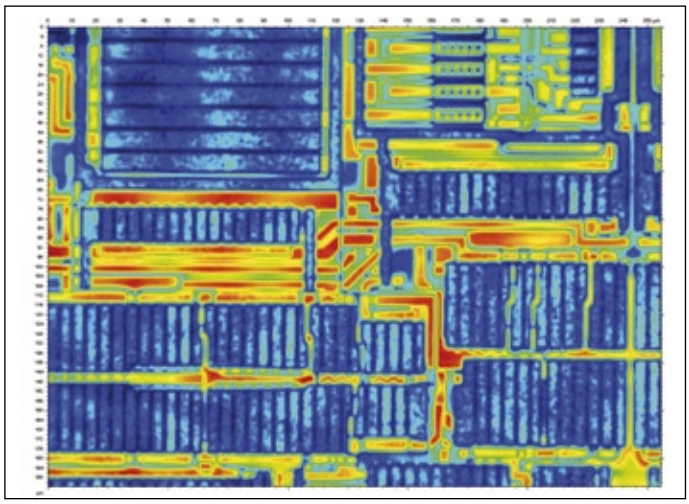
Flip Chip Mounting Defect Analysis

Flip Chips (a.k.a Controlled Collapse Chip Connection, or C4) are a common type of mounting used in the semiconductor industry. They use solder bumps instead of wires to bond components to circuitry. To do this, solder bumps are deposited on the chip pads, located on the top side of the silicon wafer, during the final processing step. To mount the chip to an external circuit e.g. a circuit board, a chip or even another wafer, it is flipped around so that the top-side is facing down to the mounting area. The solder bumps then become the direct connection.

To attach the flip chip, it is inverted bringing the solder bumps down onto the connectors of the electronics or circuit board. The solder of each bump can then be re-melted to form the required electrical connections, most often using an ultrasonic process. This leaves a small controllable gap between the chip and the circuit, which is often filled with an electrically-insulating adhesive, which ensures that the solder joints are not under too much stress if there is differential heating within the system. It also provides a much stronger mechanical connection and acts as a heat bridge.

With such a close mounting and with a filled gap, once mounted the pattern cannot be inspected using visible light. However, the silicon chip is transparent to infrared light and the interior can be





Metal structures on SI. Images acquired through 400 µm SI. Taken using a 90x lens. Filtering: single noise reduction and smoothing.

The Olympus OLS3000 Lext IR is a confocal laser scanning microscope that uses a 1310 nm laser to literally see through the silicon to the components

observed without destroying the mounted chip. Therefore defect analysis is easily performed by merely placing the device under an appropriate microscope.

Chip Scale Packaging

A chip scale package (CSP) is a single-die, direct surface mountable package with an area of no more than 1.2 x the original die area. Chip scale packages are smaller in size with reductions in footprint and thickness; they are also lighter, relatively easy to assemble and offer lower over-all production costs. CSPs also provide improved electrical performance and are tolerant of die size changes.

Chip scale packaging can combine the strengths of a number of other packaging technologies, such as the reliability of encapsulated devices, as well as the reduced size and increased performance of bare die assembly. The significant size and weight reductions offered by the CSP make it ideal for use in mobile devices like cell phones, laptops, palmtops, and digital cameras.

The ultimate type of CSP is the wafer-level CSP (WL-CSP), since the resulting package is practically the same size as the die. WL-CSP consists of extending the wafer fabrication processes to include device interconnection and device protection processes. As a result, WL-CSP paves the way for true integration of wafer fabrication, packaging, testing and burn-in at wafer level.

It is very important that these CSPs are subjected to extensive tests during development. They are therefore exposed to environmental investigations, such as heat and moisture tests to see what device changes have occurred during these tests. For example it is common to see leakage due to melting and corrosion of copper wiring and peeling of resin parts. With infrared illumination, these can all be clearly observed.

Silicon Gap Measurement

Three-dimensional mounting chip gaps can be measured using the OLS3000IR by recording the movement of the objective when infrared light is passed through the silicon then focused on the chip and interposer in turn. The distances between components are very important for their successful functioning and therefore they must be maintained as pre-determined. This method can also be used in the measurement of key features in micro-electromechanial systems (MEMS).

Wafer Grinding Measurement

As electronic components become smaller, so the thickness of the silicon wafers must decrease. At present, wafers can be manufactured at about 30 µm, but as they get thinner they become prone to warping or breaking and therefore it is important to have a good grasp of the thickness as the grinding process needs to be consistent across the entire wafer. However, the thinner they are the more difficult it becomes to measure them. With infrared microscopy though, it is possible to focus on the front and the back of the wafer in turn and the grinding amount can be measured as the movement of the objective required.

A World Leading IR Team

As well as the peerless Lext OLS3000IR, the Olympus IR microscope system range provides non-destructive inspection capabilities for all silicon-based circuits, whatever the requirements. The inverted MX series is perfect for the observation of 150–200 mm wafers. The upright BX2M microscopes offer transmitted illumination and the BXFM is equipment oriented modular optical unit enabling it to be integrated into other pieces of equipment, such as production lines for in situ inspection. With this range of IR inspection microscopes, even the most complex of silicon-based electronics can be precisely inspected and measured without the need for destruction.

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Wafer Inspection

As part of its extended product portfolio of inspection solutions for semiconductors, the desktop MX100IR system from Viscom is the ideal solution for inspection of bare wafers, chips, MEMS, wafer bonds, SOIs and FlipChips. This system with manual loading is primarily suited for inspection of smaller lots. It can also be used for applications in the photovoltaic sector. The wafers can be composed of silicon, gallium arsenide or III-IV composites. Silicon, with almost all dopings, is transparent to the scalable system light sources in the near-infrared range wavelength, so even subsurface defects can be inspected to a high resolution with ease. Evaluation is based on specialized inspection algorithms which positively locate defects such as voids, seam widths, etc. Complete statistical process control is also possible.

Viscom AG
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Flexible, High-Performance IR Camera System

Flir ATS has unveiled Titanium, a series of high performance IR camera systems that can provide outstanding results from almost any R&D or thermography application. This flexible IR camera delivers high sensitivity, accuracy, spatial resolution and speed in a compact housing (enabling implementation in small spaces) and has a removable lens interface that gives complete flexibility in the optical path. The systems are available with a wide range of detectors including state-of-the-art InSb, MCT or QWIP focal plane array detectors that achieve outstanding sensitivity of less than 18 mK even at high frame rates in both the MWIR and LWIR domains. They are programmable from 1z to 380Hz in full frame mode and offer a sub-array windowing mode with integration time adjustable in 1µs increments. An external triggering capability synchronises image capture to even the most fleeting events.

Flir ATS
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16-Frame Ultra-High Speed Camera

Specialised Imaging has delivered a SIM-16, the world's first 16 channel camera capable of capturing images at 200,000,000 frames per second, to the UK's EPSRC Engineering Instrument Pool run by the STFC Rutherford Appleton Laboratory at Didcot, Oxfordshire. Other leading UK research groups are now lining up to use the SIM-16 to for applications including plasma physics and effects of cavitation in turbines. The system is able to eliminate effects such as parallax and shading, and the high spatial resolution (> 50 lp/mm) is the same frame to frame and in both axes. An optical port for secondary recording instrumentation has been incorporated into the primary beamsplitter, overcoming simultaneous high-speed image capture problems. The SIM optical port framing camera also enables direct interfacing with high-speed video, a streak camera or a time resolved spectrometer.

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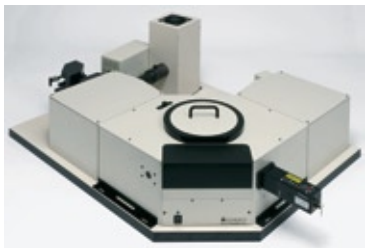
Spectrometer Demonstration System



Hamamatsu Photonics Deutschland announces the arrival of a new Edinburgh Instruments FLS 920 spectrometer demonstration system. The system is available for test measurements (steady state and TCSPC) as well as for demonstrations and exhibitions. The modular setup of the FLS 920 series and a wide choice of detectors (UV to NIR), sample holders, temperature options and excitation light sources allows not only for individually customized spectrometers but also for later upgrade. Typical spectrometer applications are steady-state fluorescence measurements, ps time-resolved fluorescence decay curves and phosphorescence characteristics of liquid and solid materials.

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Italian Sculptor Uses Laser Scanner

Using a hand-held Leica T-Scan, the Italian artist Roberto Cuoghi digitized a small statue of King Pazuzu, the ruler of demons and winds in Assyrian and Babylonian mythology. The figurine has a human body and a canine or feline head. Its claws belong to an eagle. The extremely accurate data gathered during the scan were used by Cuoghi to produce a nearly 5.8 m tall statue based on the 15 cm tall original statue of the demon. Thanks to accuracies of 30 µm, even the most delicate relief features could be captured true to life. The artist views the accuracy of the measurements as part of his creativity. The mobile high-speed device lets the user capture the finest details in very large measurement volumes. 10,000 points are scanned each second, facilitating highly accurate and dependable measurements of demanding shapes and objects with a direct comparison to the CAD values.

Leica Geosystems AG
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Dynamic Processes in 3D

Moveinspect from Aicon captures dynamic processes three dimensionally and analyses them for geometric changes. Motion and deformation behaviour, performance under load, how stable is the material used and when does it fracture – these issues can be addressed by this new measuring system, on view at the Control show in Stuttgart. A bar equipped with digital cameras can conduct tests with no time limit at a frequency of up to 500Hz. The software determines the 3D coordinates of object points, the 6 DoF coordinates of solid bodies, and the speed of the points or solid bodies. An integrated magnifier function permits visualization of the slightest movement. The results of the dynamic measurements are displayed or may be exported to external analysis software.

AICON 3D Systems GmbH
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Infrared Camera Knocks on Craftsman's Door

Flir Systems has launched the i5, a small and lightweight multi-purpose handheld infrared camera. With a weight of 340g and a length of 22 cm, this pocket-sized IR camera produces instant, point-and-shoot JPEG infrared imagery. It measures temperatures up to +250°C and shows differences as small as 0.10°C. This suits most applications in electrical, mechanical, and building environments. The temperature data can be stored internally or externally, sent and analyzed. The camera comes with QuickReport image analysis software, providing reports in PDF format, a 512MB mini SD Card, a Li-Ion rechargeable battery with charger, USB cable, hand strap, manuals and user CDs available in 21 languages.

Flir Systems GmbH
Tel.: +49/69/950090-0 • flir@flir.de • www.flir.de

High-speed Camera

i-Speed 3 is the newest member of the Olympus' high-speed camera range, enabling recordings for many different applications such as crash test/accident analysis, automobile component testing (e.g. production of windshields or tires), airbag and seatbelt testing as well as ballistic tests (by state/federal offices of criminal investigation, manufacturers of ammunition, etc.) or explosives testing. Recordings with up to 150,000 pictures per second are possible – the complete resolution of 1,280 x 1,024 is possible at a rate of 2,000 pictures per second. An F-mount objective connection, used as standard in many high speed video applications, is used for the first time on a high-speed camera system to illuminate the 2 inch chips with 10 bit monochrome and 30 bit shade of colour. The cameras are also available in an acceleration resisting (HighG) version that resists strong knocks and shakes, even "onboard".

Olympus Deutschland GmbH
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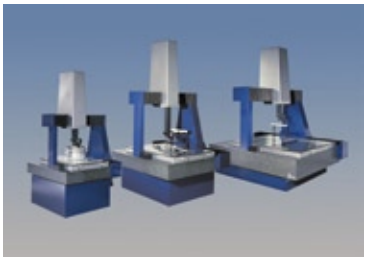
Prototype of Robotized T-Scan Application

Aicon 3D Systems, Leica Geosystems' distribution partner in Germany, showed their prototype of a large-volume laser scanner incorporated into a fully automated robot-based system for dimensional inspection in the automotive sector at this year's Control show in Stuttgart. The robotized prototype is a one-of-a-kind development eagerly awaited by the company's numerous automotive customers due to its accuracy capabilities and measurement volume of 30 meters. It digitizes almost all surfaces, from shiny to black, in one step, requires no powdering and produces immediately usable point-cloud data for real-time on-screen analysis and comparison to CAD. The whole process has been automated for customers who perform a lot of repetitive, serial inspections, for example body-in-white part inspection of large numbers of measurement objects with minimal operator interaction.

Hexagon Metrology GmbH
Tel.: +49/6441/207-0 • contact.de@hexagonmetrology.com
www.hexagonmetrology.net

Multisensor Technology For Large Measuring Ranges



Werth Messtechnik presents the Scopecheck MB multisensor coordinate measuring machine for the precise measurement of large volume components in the shop floor environment. The measuring range of this series is up to 800 mm in the X-axis and 2000 mm in the Y-axis. 3D workpieces can be scanned very quickly with high point density using the new Laser Line probe. Measurement of functional dimensions with tactile, image processing technology, or laser sensors is also possible. Free-form surfaces are quickly and completely measured with the sensor in the same coordinate system. The modular construction principle allows the measuring machine to be easily modified for future requirements after initial installation.

Werth Messtechnik GmbH
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www.werthmesstechnik.de

Optical In-line Measuring System

At the Automatica 2008 event in Munich, the measuring specialist Wenzel launched an optical measuring system to verify components directly in the production process. Work pieces are checked within the cycle time of the production line by using an intelligent camera system. Using the Metrosoft CM measuring software, it is possible to check parts directly on the production line, sending a coordinated and immediate response to the relevant instance within the production process (e.g. correction message to the production machine, allocation of relevant information to subsequent processes such as sorting, data handling, statistics etc.). Data transfer to the different interfaces uses standardized formats so interaction with CAQ systems and the logistic control works without problem.

Wenzel Präzision GmbH
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High Speed Camera With 4-fold Light Sensitivity

The new Vosskühler HCC-1000B camera has an improved light sensitivity by a factor of 4 over the previous model. With short exposure times, light sensitivity is always a critical parameter, especially in high speed cameras. The camera can be operated via the Gigabit-Ethernet connection by any suitable PC or notebook. There is almost no limitation in cable length.

VDS Vosskühler GmbH
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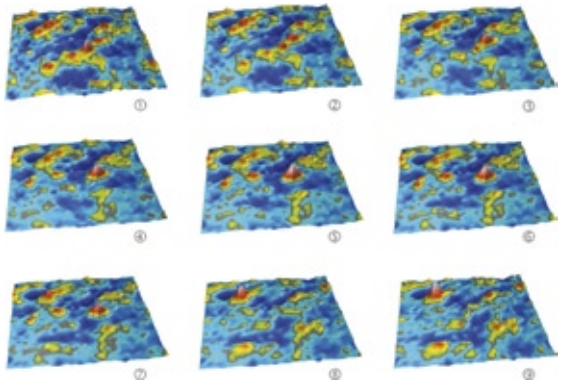
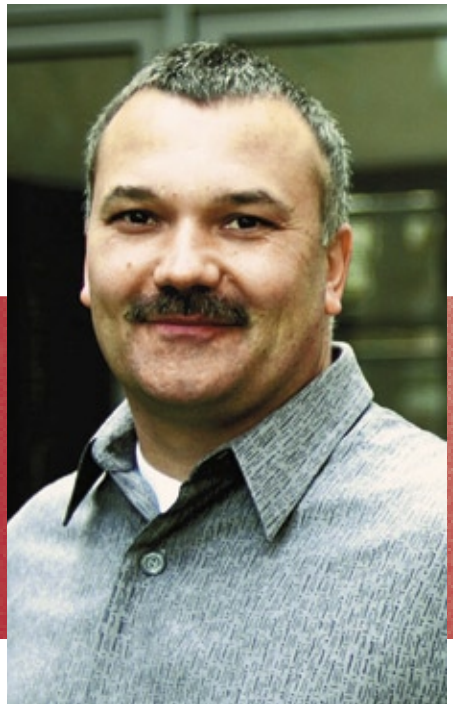
4D Module Analyses Surface Evolution



Metrological analysis of the evolution of a 3D surface in a 4th dimension is now possible using the new 4D software module in Mountains Technology v5 from Digital Surf. Changes in height on the z axis are now not only a function of the x, y position but also a 4th dimension t, which is most often time, but can equally well be temperature, pressure, magnetic field or any other physical constraint applied to an object or surface for the purpose of studying its reaction. TSimulated flights over 3D surfaces can be output to a video file for animated presentations. Powerful analysis tools manipulate and quantify 4D surfaces z=f(x ,y, t), for example, to follow the evolution of a point or a zone over time or to correlate the evolution of a surface texture parameter with the evolution of another physical unit.

Digital Surf
Tel.: +49/7223/9539-300 • contact@digitalsurf.fr • www.digitalsurf.com



Visionary

Interview with Frank Grube, CEO Allied Vision Technologies

INSPECT: At the 2007 Vision show in Stuttgart, AVT showed a couple of entertainment implementations for their cameras. Was that mainly to attract trade show visitors or is the usage of industrial cameras in entertainment applications really significant?

Grube: Of course, the aim of the entertainment applications displayed was to attract attention of the visitors – which, by the way, was very successful. But in fact, markets beyond the factory floor are gaining importance. Entertainment is one of these new market areas which is growing quite strongly. Examples of where our cameras are used in entertainment applications include roller-coasters, golf-analysis, and interactive visual display applications. This is a very broad market where a large number of applications still have not been addressed. We believe that entertainment is developing into an attractive market-niche for manufacturers who used to only address the machine vision market.

AVT's origins are in developing cameras for production environments. Is that still the main focus for the company and how do you see this evolve into other industries?

Grube: Machine vision applications still represent the single largest share of our sales. However, other non-production related industries like medical applications, traffic and entertainment, among others, are growing quite strongly and have already reached a substantial share of total sales. Machine vision will remain the most important market for our cameras in the near future but the other markets will gain in size and importance. Further, these other markets benefit from the industrial nature of our products. I look forward to addressing even more markets and applications – with our set up, AVT is well positioned to address specific needs.

Are the technical demands from non-production fields of use similar to the requirements that AVT is used to from your "production" customers?

Grube: Each application has its specific requirements – this is even more so for differing markets. Our cameras are equipped with a wide spectrum of special feature-sets our customers use to fulfill their every need. It is true that applications outside the factory-floor sometimes demand an additional feature-set or even a specific development on the hardware-side. AVT is well known in the market for our capability to quickly develop OEM-specific products and produce them at the same high quality level as a standard product. So to answer your question, the technical needs usually can be fulfilled with a standard product with a wide feature set. Some applications require additional feature-sets or hardware development which is also true for machine vision applications. But with an experienced development partner like AVT, these OEM-specific developments can be executed reliably and in time.

Nowadays the main topic in relation to cameras seems to be the camera interface. Is the interface really of so much importance compared to other technical features of the camera?

Grube: The interface determines key attributes of the solution. The variety of technical choices within the camera (variety of sensors etc.) is relatively similar for all interfaces. Therefore the interface in my eyes is the single most important criterion for the selection of a camera. But of course there is a concert of characteristics that need to play together to build the best solution for a vision task. The customer has to ask themselves what the application requires (speed, deterministic image transmission, cable-length, availability of image-processing-libraries, single or multiple camera solution, a standardized interface, etc.). Especially for machinevision applications there are demanding requirements for many of these selection criteria. For example, in inspection applications there is a need for deterministic image transmission at a high speed. The support of the interface by image processing libraries in machine vision is essential. Cable length is becoming more of an issue. For FireWire cameras the restriction can be overcome by fiber optic cables or standard cable repeaters. Gigabit Ethernet cameras do not have a restriction here. If you want to run a multi-camera application FireWire currently is the interface of choice. Last but not least, a standardized interface has the advantage of not depending on proprietary knowledge. In

the context of vision applications, only GigE and FireWire are standardized (GenICam and DCAM respectively).

How do you expect the camera market to develop in the next five years? Will we see an ever increasing number of suppliers or a consolidation?

Grube: I am sure that the number of suppliers will decrease substantially within the next few years. AVT's recent acquisition of the Canadian camera manufacturer Prosilica is the latest sign of this trend. Manufacturers can profit substantially from merging the competencies and portfolios of companies. Customers benefit with a more complete product portfolio, array of services, and global support. AVT and Prosilica are a perfect match. Our combined strengths and market positions have created an industry leading product range of GigE and FireWire cameras and accessories, and therefore have extended our market leading position in the area of digital cameras for industrial image processing.

At the moment I see the market at its peak in respect to the number of suppliers – the market is very fragmented. There are a large number of very small players with less than ten employees. For most customers, the size of a supplier is important because this at least gives an indication that the products have a guaranteed future. I expect a lot of merger activity to take place in the future. In the future, there will be a limited number of dominating players in the market. Allied Vision Technologies is positioned in such a way that we will be one of them. We have the market position, financial strength and the support of our parent company Augusta Technologie AG to take this next step and become not only the market leader in FireWire cameras as we are today, but to become the number one digital camera manufacturer in our market.

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