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INSPECT

World of 3D

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Interferometry, Chromatic Aberration

Triangulation, Stripe Projection, Sheet-of-Light

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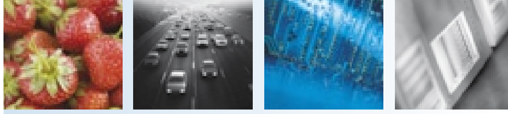

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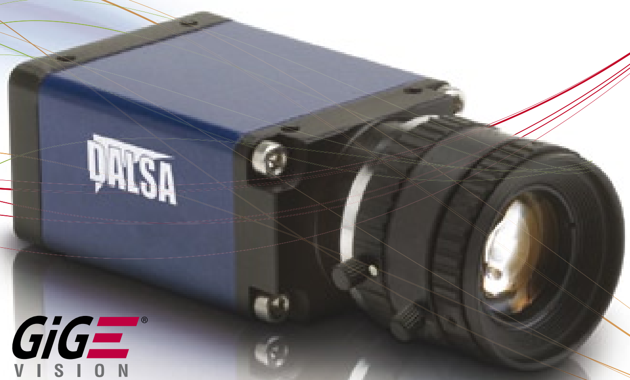

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www.dalsa.com/gige/i11

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Afraid of Strategy?

Canadian professor Henry Mintzberg, enfant terrible among the management gurus and author of over 140 papers and ten books about strategy and management, defines strategy as the interaction of five aspects crucial for strategic management: plan (intent to act), ploy (maneuver to defeat the enemy), pattern (consistent behavior), position (positioning of an organization within the environment), and perspective (view on and interpretation of the world).

According to him a strategy defines the behavior of an organization towards reaching its goals. It encompasses the values as well the resources of the organization, but also takes into account its environment and its position within the competitive field. From company strategy product strategy is deduced as well as finance strategy, marketing strategy, acquisition strategy, and so forth.

Strategy as a buzzword is used rather more often than applicable in companies of all sizes and industries. A well defined company strategy, on the other hand, is missing more often than not – not even talking about any derived sub-strategies. This is especially true for the small and medium enterprises of our industry. This is not due to any lack of understanding the necessity of strategic planning, or the ability to understand cause and effect, for that matter (no company strategy – no marketing strategy to be derived, for example). The core of the problem does also not rest in the fact that smaller enterprises are lacking staff divisions exclusively engaged in strategy and planning.

The real problem is the goal. A strategy defines how a company has set out to reach their goal, their business objective. Thus, a strategy requires that a goal has been defined. A goal in turn is characterized by being clearly definable, measurable and achievable within an appointed period of time. The crux of the matter lies in the clear definition of the goal since this definition automatically rules out a whole wealth of other possible objectives. By deciding on the goal the company leader necessarily runs a risk, the risk of a wrong decision.

Due to the diversity of machine vision and optical metrology technologies, the heterogeneity of potential customer industries, the constantly growing range of applications, and the increasing accessibility of international markets a very tempting and large field of operation is open to the company. On top of that an interminable flow of demands for new products and new features comes from the markets, from the customer side. To set goals in such an environment clearly requires letting go a lot of other options. But maybe the pot of gold at the end of the rainbow would have been exactly there, at the direction just abandoned. One cannot deprive oneself of this opportunity, can one?

A lot of companies try to face this dilemma by constantly keeping all options open, not setting any clear company goals, and abstaining from a company strategy instead. Obviously a company can be managed in this way, a small company maybe even somewhat profitably. To reach the pot of gold, however, is entirely left to chance this way.

The big success, the above average growth, the market leadership, – and fulfilling the desire of every entrepreneur to have earned more than one‘s own pension at the end of the day –, all this will only come when a clear goal is set, a strategy defined and measures derived allowing the company as a whole to focus all forces on reaching the joint goal.

In this issue of INSPECT you will find again contributions from companies having dedicated themselves successfully to their goals. Enjoy reading all about the “World of 3D.”

Gabriele Jansen
Publishing Director INSPECT

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10th Oldenburger 3D Days

Next year's 3D Days in Oldenburg will bring together users and service-providers, researchers and developers of different specialist areas. On February, 2 and 3, 2011, research results, current developments and questions as well as the wide area of application of optical 3D measurement methods will be addressed in more than 40 special lectures. The Oldenburger 3D Days regard themselves as a platform for the exchange of experiences at an interdisciplinary level. This is why the conference program is aligned in time to have enough time to visit the accompanying industry exhibition and to see state-of-the-art developments in the market as well as to network with colleagues. The organizers are supported by the Lower Saxony's research network "Image Sensor Techniques," www. bildgebende-sensortechnik.net.

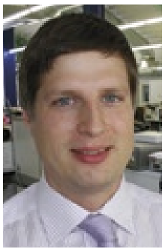
www.jade-hs.de/3dtage

New Name, Proven Services

Since October 1, 2010 Messtechnik Wetzlar GmbH is sporting a new name. The company will operate in future as Hexagon Metrology PTS GmbH – PowerTrain Solutions. Parent company Hexagon AB took over the German firm in June 2008. Integration is now perfect with this change of name. "We are sending a clear signal with the new company name," says Per Holmberg, Hexagon Metrology President Europe. "Hexagon Metrology PTS GmbH is part of our worldwide network and therefore a global player. The company is an important component of our portfolio and a top choice for our powertrain customers."

www.hexagonmetrology.com

New Sensor Development Manager



Dr. Thomas Wißpeintner took over as Sensor Development Manager at Micro-Epsilon. As son of the company's founder, Thomas Wißpeintner is now responsible for the further development of the company's electromagnetic sensors. For his Doctorate, Thomas developed a modular system for the fast realisation of robot applications at the Fraunhofer Institute in Sankt Augustin. Dr. Thomas Wißpeintner was also heavily involved in the development of the driverless vehicle "Spirit of Berlin" and in initiating a competition for assistance and service of robots with the name RoboCup@Home.

www.micro-epsilon.com

New Imaging Technologies Raises € 3 MillionsVenture Capital

CMOS image sensor start-up New Imaging Technologies (NIT) has successfully concluded a round of private equity financing from several prestigious French high-tech investment firms totaling € 3 million. The new round of investment for NIT is oriented towards the ongoing development of innovative CMOS image sensor technologies and further business expansion. "We are convinced that NIT's Wide Dynamic Range Technology has the potential to be a leader in the growing market of CMOS image sensor technology," says Jean Philippe Gendre, Partner at Emertec Gestion. "NIT's unique Native WDR technology can cover a broad range of applications that were previously not addressed because of the lack of available sensors with such performances." "This substantial capital increase will allow us to implement in time our strategic roadmap of new product introduction and sales development," says Pierre Potet President of NIT.

www.new-imaging-technologies.com

Basler Increases Camera Sales by 85%

The third quarter of 2010 went better than expected for Basler AG. According to preliminary figures, sales and pre-tax earnings were significantly above previous year's levels and beyond the management board's expectations. Group sales for the first three quarters of 2010 were at € 38 million, exceeding the previous year's level of € 24 million by 58%. Earnings before taxes (EBT) for the group amounted to € 3.8 million, up € 11.6 million compared the previous year's results. Assuming continued market development, Basler is once again increasing their guidance for the 2010 fiscal year. Group sales is expected to grow to a level between € 46 and € 48 million at an EBT of no less than € 4.1 million.

www.baslerweb.com

Opto Turns 30

Opto, German developer and integrator of specialist optical inspection technologies celebrates its 30th birthday tis year. Opto was founded in 1980, in the small western district of Munich with a vision to be a supplier of custom solutions and accessories for stereo microscopes. Today Opto has grown into a 30 person company with worldwide sales and branch offices in France and the UK. Commenting on the occasion, owner and CEO Markus Riedi stated: "We've come a long, long way in our 30 years, but always have evolved with the same simple three-fold approach to our business: 1. to never stop learning about our core technologies, 2. to always push the boundaries of what is possible with our ability and 3. to enjoy what we do. This approach has enabled us to develop many totally unique optical solutions, modules and systems for some of the world's most demanding optical vision related applications. During our history, we are proud to have played our part in the ongoing advancement of industrial imaging science in numerous emerging technologies.

www.opto.de

New Volpi AG Management Line-up

Headquartered in Schlieren, Switzerland, Volpi AG has long been well regarded as a specialist in fiber-optical and optoelectronic lighting systems. To help prepare for the future, the company is not only focusing on intensive and practice-oriented development in photonics, but also optimizes its corporate structure and organization: Max Kunz, owner and CEO of Volpi AG has now decided to expand the management team. Dr. Scott Kittelberger (COO Volpi USA), Thomas Trachsler (Director Sales & Marketing), Thomas Baumann (CFO), Jan Hauser (Head of R&D) and Reinhard Jenny (CTO) have joined the executive board. "This restructuring is a vital step into the future. Corporate communication routes are now shortened, and resources are available to all group divisions. This will increase the efficiency of our work, which eventually, of course, will benefit the customer," Max Kunz explains. At the same time, this should set the stage for future growth. "Smooth cooperation between our divisions in Switzerland and the US will facilitate easier realization of new sites, such as in Asia; it will also enable new cooperation opportunities, setting the stage for future growth," Kunz concludes.

www.volpi.ch

VDMA Robotics and Automation: Back to the Growth Path

The producers of industrial machine vision, assembly and handling technologies, and robotics will see turnover figures increase in 2010 by 14% to € 7.1 billion. "The steady recovery of orders received since the beginning of this year enables us to raise our forecast for this year's turnover significantly", Dr Michael Wenzel, Chairman of VDMA Robotics + Automation, explains the current trend on the side-lines of a board meeting of the association on October 7, 2010 in Munich, Germany. And: "We expect our industry to further grow in 2011, presumably in the region of 10% ." "The machine vision manufacturers are the most dynamic with a growth of +18% (to € 1.1 billion)," Dr Olaf Munkelt, Chairman of VDMA Machine Vision happily says. "Projects that were put on ice in 2009, are now back on the agenda," he explains the favourable development. Even more so, the forecast strong demand for machine vision components in the months to come will further add to the turnover generated by overall systems Machine vision, assembly and handling technology as well as robotics will play a major role and help us solve the big challenges society faces. For example, profitable serial production of energy storages is key to electrical mobility on a truly large scale. And also the demographic development calls for novel assistance systems in production, in order to ensure that companies remain productive in the medium and long term, too. The intelligent use of automation technology thus becomes a strategic success factor for German producers.

www.vdma.org/r+a

Mahr Receives Award for Its International Activities

The application specialist Mahr has received the GlobalConnect Award 2010 in the category "Global Player". The prize was awarded end of October during a reception of the state government of Baden-Württemberg. The GlobalConnect Award distinguishes businesses that have successfully established themselves abroad with new ideas. The competition takes place nationwide every two years and is jointly organized by the Chamber of Trade and Commerce, Handwerk International and Messe Stuttgart. The jury selected the measuring solution oriented supplier Mahr this year in the category "Global Player" due to its very successful expansion strategy and unique selling proposition with which it distinguishes itself from its competitors. Mahr GmbH, founded in 1861, has been active abroad since 1965 and in the meantime is the third largest manufacturer of production metrology worldwide. Its export share exceeds 40% and the company exports to 50 different countries. Mahr has a well-functioning network of 15 subsidiaries and 35 representatives. It was Mahr's uniquely extensive product portfolio that especially convinced the jury. Customers can purchase all units needed for dimensional metrology from one source. As an application specialist, Mahr offers measuring solutions starting from technical advising to technology up to measuring device management including calibrations. Mahr's strategy abroad focuses on already developed markets in industrial countries as well as on future selling markets in China, India and Brazil. Its production strategy is globally designed and takes favorable production possibilities as well as the availability of raw materials into consideration.

www.mahr.com

High Tech Coupled with Finesse

Calibrated 3D Area Sensor for Industrial Image Processing

In part inspection, 2D machine vision sometimes gets to its limits, namely when the contrast is too low, or the lighting conditions vary too much. Not so with 3D machine vision: Here the digital stripe light projection ensures the decoupling of image acquisition quality and lighting conditions. Thus, a 3D sensor supplies much more meaningful raw data than the traditional 2D sensor.

Not only in the movies, also in machine vision 3D technology is rapidly gaining in popularity. 3D systems simplify many industrial applications in which conventional 2D image processing requires implementation of highly complex solutions. In recent years, there have been a host of interesting new developments both in the area of image acquisition of three-dimensional objects and 3D image processing software. 3D image processing systems are already used for object measurement and testing in the fields of automation and robotics. In addition to a comparison of target and actual variables, 3D image acquisition of objects can also significantly optimize production processes for inspection tasks relating to position and completeness. Robust and easy-to-integrate image acquisition technology is an essential prerequisite for efficient use of 3D technology in an industrial environment.

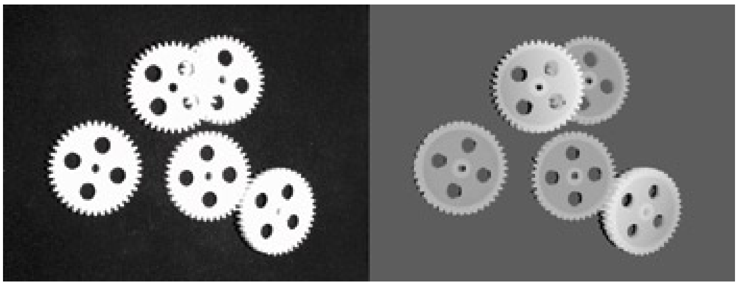
This is now presented by the German camera manufacturer VRmagic with its new 3D area sensor. This sensor is based on digital stripe light projection and supplies ready-calculated 3D data records for industrial image processing. The AreaScan3D sensor outputs the recorded 3D data to the evaluation computer via the standardized Ethernet interface. The data is output directly as a point cloudor a grayscale-coded range map. Image processing can then take place in this computer, e.g. to check the completeness of free-form components. The AreaScan3D sensor is addressed via a GenICam transport layer (GenTL). The

A Wealth of Possibilities

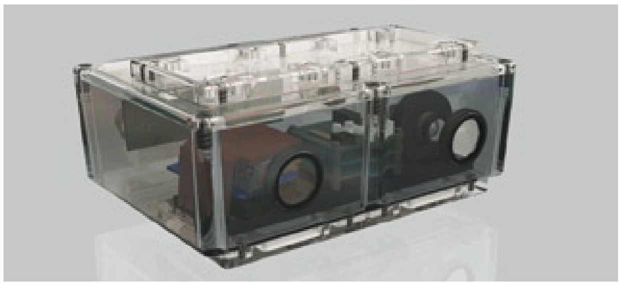
In many countries, the company Stemmer Imaging will be exclusively responsible for distribution of AreaScan3D. INSPECT spoke with Peter Keppler, Sales Manager at Stemmer Imaging, about 3D machine vision and the 3D sensor.

INSPECT: During recent years 3D imaging has taken a large technological step. Not only as far as the acquisition of 3D images is concerned, but also in regard to analysis algorithms. Interesting technologies are now available and impressive applications have been realised. What has been accomplished at Stemmer Imaging?

P. Keppler: For the last few years Stemmer Imaging has been working with this technology and offers different acquisition hardware as well powerful analysing algorithms. Of special interest are the 3D tools from the independent image processing library Common Vision Blox with an emphasis on completeness checks



The advantages of 3D pre-processing are shown by this grayscale-coded range map: three-dimensional image acquisition offers more meaningful data than a two-dimensional camera image



The interior of the 3D area sensor in a schematic presentation

3D sensor is therefore compatible with all image processing libraries and packages that can already communicate with a GenTL, such as Common Vision Blox or Halcon.

Plug & Play Technology

The 3D sensor can be integrated in robots and automation installations via the Ethernet interface. The sensor features a robust metal housing with IP65 protection, screw-type standard industrial connectors, a 24 V connection, an Ethernet interface as well as hardware and software triggers.

"We are offering plug and play technology with an extremely interesting cost-benefit ratio," says Oliver Menken, Sales Manager at VRmagic. "The advantages of 3D technology for machine vision are above all in decoupling of lighting problems. Compared with classic 2D image processing, optical 3D measurement with stripe light projection can offer more efficient and robust testing methods. Particularly for inspection objects with low contrast or under varying lighting conditions, 3D data acquisition frequently supplies much more meaningful raw data. This data can then also be analyzed using conventional 2D inspection algorithms."

High Measuring Accuracy

The AreaScan3D sensor offers maximum external light stability through use of a color LED combined with a band-pass filter. The material color also does not have any influence on measuring accuracy. The sensor is a ready-calibrated system and supplies metrically calibrated images with guaranteed measuring accuracy for non-moving objects. The image acquisition time is less than one second. "Stripe projection, image acquisition and generation of the point cloud are performed in an integrated manner based on an intelligent camera from VRmagic," explains Menken. "The DLP pico projector from Texas Instruments and the camera are synchronized with a frequency of 60 Hz." Output of a complete 3D data record is currently possible with approximately 360,000 individual points per scan. The AreaScan3D sensor is available with measuring fields ranging from a few millimeters up to a square meter. It offers a guaranteed accuracy in the submicrometer to millimeter range, depending on the size of the field-of-view.

The AreaScan3D features a robust metal housing with IP65 protection, screw-type standard industrial connectors, a 24 V connection, an Ethernet interface as well as hardware and software triggers

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www.stemmer-imaging.de

of free-form objects. The CVB tools work in real 3D space processing point clouds plus all other 2D-tools within CVB can be used with the 2.5D grey scale coded images produced by 3D cameras.

Which requirements have to be fulfilled by a 3D sensor in the industrial field?

P. Keppler: In order to better establish 3D technology, a robust and easy to integrate acquisition technology is necessary. This technology has to offer high precision at a realistic price in order to be competitive with other 2D or 3D solutions. VRmagic specifically developed their new AreaScan 3D sensor to meet those basic conditions. The flexible stripe light generation with a DLP projector allows the easy acquisition of 3D image data of non-moving objects. The complete system including camera and digital stripe light projection is calibrated and delivers metrically calibrated images. The IP65 housing with screwable standard industrial connectors fulfils industrial requirements. The camera is available for different fields of view that are tailored to typical industrial applications.

Which application possibilities do you envision for the AreaScan3D sensor?

P. Keppler: In combination with the CVB 3D tools, but also with algorithms from other manufacturers, this sensor will open up interesting new possibilities in the industrial field. Applications and markets for this technology are mainly completeness checks for free-form objects using CVB Match 3D, PCB inspection, logistics applications, food and packaging applications, or robotic pick & place applications.

SPS/IPC/Drives 2010

Exhibition Area of SPS/IPC/Drives in Nuremberg, Germany, at Record Level

SPS/IPC/Drives, trade fair for electric automation technology, takes place in Nuremberg, Germany, from November, 23 till November 25, 2010. With 90,000 m², the organizers are now announcing a record level in exhibition space.

About 1,300 exhibitors present their products at this year's SPS/IPC/Drives in Nuremberg, Germany. Visitors will find a huge portfolio of systems and components for every aspect of the electric automation technology. And of course, this includes machine vision components and systems. In many cases, they are assigned to the product group of sensors which are primarily exhibited in hall 4A. Apart from identification sensors and systems innovations in the field of 3D machine vision will be shown but also components, like cameras, smart cameras, vision sensors and illumination solutions. According to the trade fair organizer Mesago, several product premieres are announced. In order that visitors have enough time to attend one or two talks, furthermore, the trade fair will be opened till 7 p.m. on Tuesday and Wednesday.

Special Themes and Forum

This year again, the trade fair's organizers feature special themes at the SPS/IPC/Drives. These are energy efficiency, industrial identification and safety and security. Several speakers talk in the show forums of the associations ZVEI (hall 8) and VDMA (hall 4A) about these topics. Also will the congress, taking place in parallel to the trade fair, address these special themes. This year, the highlight of the congress is the guest lecture of Prof. Dieter Spath with the topic "from evolutionary to revolutionary innovations." He will show how companies stay competitive in today's global markets with systematic technology and innovation management.

Young Engineer Award

For the first time, two young engineers will be awarded during the congress of SPS/IPC/Drives. The best entries in the categories automation and drives, respectively, will be honored. The official award ceremony will take place on November, 24 at an evening event.

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It's about Time

Review: Technology and User Congress "Virtual Instruments in Practice – VIP 2010"

From October, 27 till October, 28, National Instruments organized for the 15th time the technology and user congress "Virtual Instruments in Practice – VIP 2010". The 635 participants were presented with an interesting agenda in the event forum in Fürstenfeld, Germany: Technology and user presentations were offered, as well as workshops for both beginners and advanced users and an accompanying exhibition. Once again, the highlight of the event was the R&D keynote moderated by Rahman Jamal, Technical Director Central Europe. On the second congress day he presented several new products and used time as a common theme. Measurement technology's goal is more and more to save time in test applications. That is, what the company tries with its new PXI based switch module solutions.

A James Bond Sensor

Jamal also introduced the new fiber-optical sensor interrogator, a PXI express module for fiber bragg grating sensors (FBGS). "Sounds like James Bond", John Pasquarette, National Instruments' Vice President Software from USA, commented this type of sensor. They work in that manner, that they reflect the wave length which corresponds with the physical parameters like temperature or extension. The advantage: They are insensitive to electromagnetic interferences and ensure measurements with distances more than ten kilometers thanks to the fiber-optical cable.

Inclusive Concrete Applications

As in previous years, the submitted abstracts are published in accompanying congress proceedings for the VIP congress 2010. Concrete applications document how the several NI tools, like NI LabView, NI TestStand or NI DIAdem, are used in practice.

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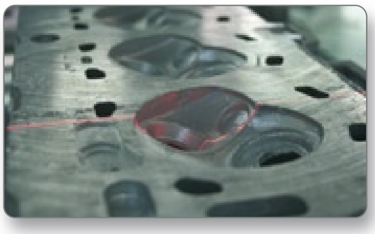

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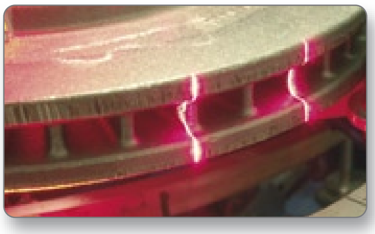

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Industrial 3D Sensors – Where Will the Journey Lead?

Insights into and Outlooks on the Development of 3D Machine Vision

Not only Vision, internationally leading trade show for machine vision early November in Stuttgart, has shown it; also the market analyses of the leading trade associations clearly point it out: The use of 3D technologies in industrial quality control and automation is on the rise. How then is the market for 3D sensors evolving over the next years? This article tries to draw a picture based on historic and current technology trends and some economic factors.

Evolutionary Historic Development

3D sensor development has always been linked to the technical development of industrial image processing (machine vision) in general, no matter which of the several methods will be applied. During the past 30 years many innovations have enabled a step by step entry of image processing in industrial applications. In the 80s this has been moving from analog towards CCD cameras, in the 90s the massive increase in computing power on low cost PC systems was responsible. In the past 10 years fast digital image sensors and electronics paved the way for 3D systems, especially for scanning laser systems and the sheet-of-light approach.

It is characteristic for this historic development that all 3D methods have been made available on a larger scope only through innovations in mainstream markets resulting in a distinct price degression. Besides PC performance and high performance image sensors, many other technological improvements have to be pointed out here, like enhancements in laser diodes and the advent of structured light projection technologies. But structural factors, like the availability of well educated software developers and the small-scale structure of the machine vision and integrator markets have also contributed to this development. The value creation of the entire market is given by the intelligent combination of products that have been developed primarily by and for other markets. This will not change in the future.

State of the Art

This consideration is limited to those 3D systems and methods that are or have the potential to be mass produced. Apart from some more qualitative methods (e.g. deflectometry, shape from shading) there are two physically different sensor principles: triangulation and coherence radar (white-light interferometry and time-of-flight). Triangulation based systems can be divided onto light sheet based and fringe projection systems, see e.g. [1] for more details. Laser based light sheet methods have the advantage that even highly textured surfaces with low reflectivity can be still sampled safely. However the object needs to be moved. Due to the high speckle contrast the measurement uncertainty for technical surfaces is on the order of 10 microns (e.g. [2]) and can only be improved by spatial averaging. Fringe projection methods in contrast project a sequence of white-light patterns onto the object; the object does not need to be moved. The advantages of this method is the smaller measurement uncertainty, typically a much higher number of 3D points per measurement as well as the possibility to measure larger areas. Although white light interferometers represent the most universal method (coaxial arrangement, high resolution) the factory floor applications are still limited due to the long acquisition time.

Cost and Other Barriers

In Europe alone there are several hundred manufacturers of image processing hardware and software. Most of them with revenues below 10 Mio. EUR. The reason for this might be due to the relatively low entry barriers but also be due to high degree of specialization companies have evolved to address the needs of their customers. A similar scenario applies to system integrators: in Germany alone there are currently more than 400 companies of this type to be found. As a consequence the relative market power of each single player is comparatively low which in turn is leading to competition on price, subsequently decreasing prices on the one hand and low buying power on the other hand. This situation forces many manufacturers and system integrators to stay in their niche markets. Often there are not sufficient funds available to develop solutions that address a broader market.

System integrators and in certain cases also end customers as direct buyers of 3D systems mainly focus on two goals: to come up with a satisfactory technical solution for a given task that is often accompanied by harsh price targets and to implement this solution most efficiently. System integrators often answer with a frown when considering these aspects: When does it make sense to use a 3D method compared to a traditional image processing solution? How much does it cost to get a grip on the new technology? The natural reaction of the integrator to 3D systems is skepticism, in many cases 3D is bypassed if familiar image processing methods can be applied although the margin might be smaller. Smaller integrators often even reject projects in cases where 3D cannot be avoided. Often a cost barrier related to getting familiar with a specific 3D system (especially familiarizing with software interfaces, adaptation to existing software modules, definition and implementation of a quality assurance strategy) is suspected that could erode project profits. Many system integrators also see risks in working with a specific system because it is unclear if and when initial development efforts can be leveraged by reuse of the results in further projects.

As a consequence of this some of the 3D product manufacturers have extended their go-to-market models by forward integration of offering complete inline control equipment in addition to the 3D components. It is interesting to mention that no camera manufacturer would think about doing something similar.

Drivers for 3D

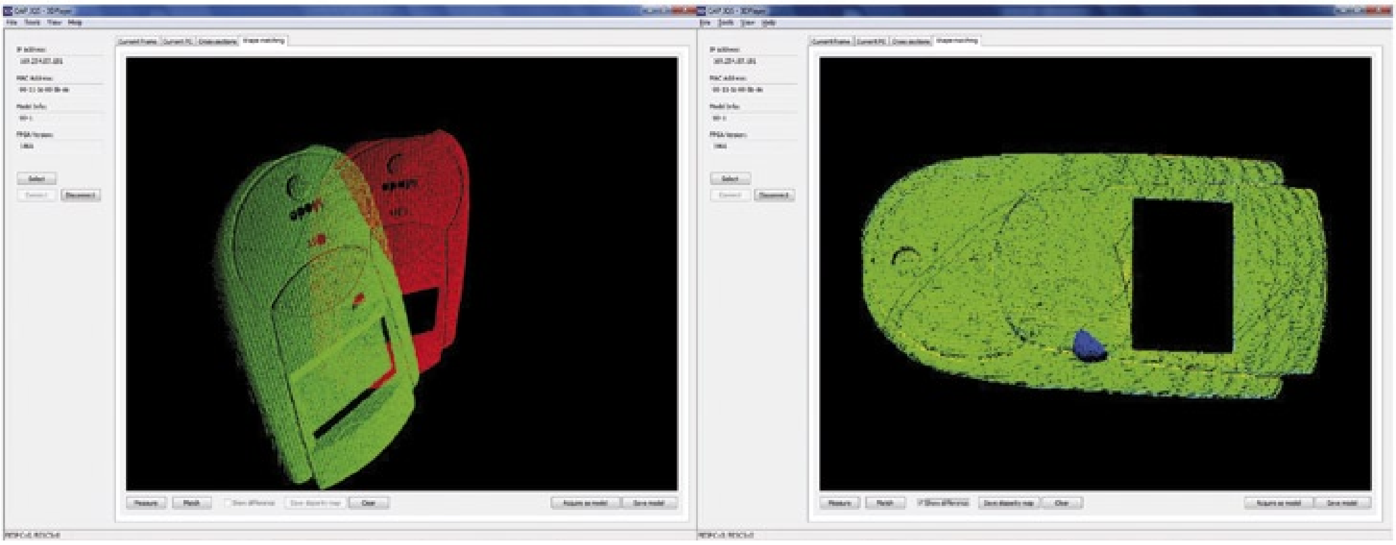
Several factors will lead to a further increasing zero defect/6 sigma quality consciousness: with an increasing number of outsourced sub components, not part of the core competence of the company, which can be observed e.g. in the automotive industry the number of supplier/OEM interfaces that need to be quality controlled steadily increases as well. In addition, particularly large companies are anxious to avoid serious costs and loss of prestige in cases of quality problems. As a consequence more and more 100% inline quality control systems will be introduced and 3D methods will play an important role. The increasing level of integration of hybrid components and shrinking footprints will further foster the demand of 3D systems.

Where economically viable the degree of automation will continue to increase, e.g. for the complex, robot guided transport of components (the well known "random bin picking"). This requires fast 3D „seeing" and recognition capabilities.

Future Scenario

The briefly mentioned 3D methods will be further improved - slowly and steadily. With the further improvement of LED projectors the fringe projection based methods will gain momentum because they do not require any part or sensor movement and are thus faster and more flexible in use. Laser scanners and the well-established sheet of light methods will be used for more simple QC tasks, e.g. presence checking, weld seam control, etc.. Should superfast, high resolution CMOS image sensors become available at realistic prices (however there is no mainstream market visible for this, see first section) white light interferometry could become interesting for inline QC. TOF systems with their limited spatial resolution will be found preferably in numerous applications like driver assistance systems, obstacle recognition and for advanced gaming applications.

Further software development will play a key role. Currently it is still not so easy to establish relevant criteria for QC purposes, compared to industrial image processing methods. With the advent of fast shape matching algorithms, i.e. the fast superposition of measured 3D data and master data, an important first



Example of a real time quality control task (plastic enclosures) carried out with ShapeDrive sensors and Shape Matching, left: Master (red), measured part dent type failure (green), right: height difference map after automatic superposition of both parts, the failure is clearly visible (blue), green means a deviation of less than 50 µm, the process cycle time is less than 1s.

step has been made. Software developers must provide easy-to-use, robust and properly structured tools.

New Markets and Applications

The demand for 3D systems is real and is not only preached by an increasingly

ShapeDrive Sensor

mature machine vision industry. Due to high costs and complexity in the 90s people thought about introducing 3D only in presumably serious QC topics (one example is the QC problem with tiny dents in car doors which become visible only after the whole car has been painted). Today systems can be realized for a fraction of the costs and with much higher performance. Thus new markets for 3D vision can be created. Examples for these new applications are to be found in the food processing industry or in medical engineering. The costs and the performance of 3D systems have become attractive for those markets and applications. This trend will continue.

With an increasing number of successful projects the demand for 3D systems will increase - but only gradually. Integrators can and will use 3D as a differentiator in competition as soon as they learn to efficiently implement solutions internally and for their customers. Otherwise integrators will play a more passive role. The manufacturers of 3D equipment on the other hand must put efforts in reducing the complexity of the 3D products and establish adequate tools to ease the implementation of these products and thus shorten the deployment time for the integrator. Successful manufacturers will offer open 3D systems (standardized software interfaces, a portfolio of standard 3D processing methods). This reduces the risk for the system integrator to deal with just one manufacturer. QC software modules developed by the integrator can then be reused with no or only small modifications.

ShapeDrive has developed a platform of sensors based on fringe projection that addresses several current market needs: a fast, integrated and open 3D system at costs slightly above those of regular cameras.

Outlook

Within the next 5 years all participants of the value chain, i.e. manufacturers, VARs, integrators and end customers will come together and define a common set of guide lines, standardized hardware and software interfaces, and software tools. The motivation for these efforts will be to provide more application safety to system integrators and end customers.

There might be a limited number of smaller consolidation phases: 1. vertical integration (system integrator buys hardware and/or software manufacturer to secure turnkey oriented strategy) and 2. horizontal integration (camera manufacturer buys 3D manufacturer for buying power and sales synergies). Larger acquisitions could occur if it is foreseeable that 3D applications with high potential will emerge so that market concentration becomes economically rewarding. Robot Vision, although being a complex field, could be such an emerging application.

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Products of the Future

EuroMold 2010 in Frankfurt, Germany, with e-Production Special

The 17th EuroMold, World Fair for Moldmaking and Tooling, Design and Application Development, takes place in Frankfurt, Germany from December, 1 till December, 4. 1,500 exhibitors from 45 countries and about 60,000 professional visitors are expected.

In an area of around 75,000 m², EuroMold 2010 shows the innovations in all fields of application development in the exhibition halls 8,9,11 and the Galleria of Messe Frankfurt. With the trade fair concept "from design to prototyping to series production", EuroMold aims to represent the whole process chain. Therewith, the show brings together the involved parties from the application development field – from designers to mould and machine manufacturers, suppliers and users. In addition to the trade show's focus on moldmaking there are several other fields presented at EuroMold, like rapid prototyping, model and prototype construction or simulation.

Crowd Puller: e-Production

Highlights at the EuroMold 2010 are the special shows „Energy Efficiency and Moldmaking" in hall 8 and „e-production for everyone" in hall 11. With the latter, the trade fair takes the enormous progress in the additive technology market into account which is worth billions. The special show celebrated its premiere at EuroMold 2009 and with the representation of future products it has proven to be a crowd puller. Furthermore, the trade fair thus expands its position as the most important European market place for additive technologies (rapid manufacturing and rapid prototyping). Several market leaders from around the world show their innovations and numerous world-first products. The application field of the products made with additive technologies grows rapidly and plays a more and more important role in industry and everyday live. Important applications fields are medical products, niche products, design and e-products distributed in the web. In order to manufacture these parts, they have to be inspected permanently on their mould and dimensions. Above all, the three-dimensional detection of the parts is essential for the quality assurance. Preferably, the inspection systems should be integrated in the manufacturing process. Those are the reasons why several machine vision providers and specialists in quality assurance exhibit at the EuroMold show.

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Learned in School – Learned for Life

Optical Metrology Basics: Triangulation

Triangulation is a trigonometric method to determine the distance between a reference point and a point of interest by aiming at the target from two different positions. In a so-called triangulation sensor this principle is put into practice and utilized for optical metrology: a laser beam is directed onto a surface at a well-defined angle of incidence, and the spot is picked up at a different angle and imaged onto a detector array [1]. Combined with a scanner or a linear drive, the complete surface of the object may be probed and can be depicted as a point cloud in three-dimensional space. This article describes the basic features of triangulation sensors.

The idea behind triangulation is quite basic, carefully planted into children at school during trigonometry lessons with more or less success, and may later on be revisited at numerous occasions if you care to watch out. With a glimpse at figure 1 you will instantly get the point. Just assume that the distance between point B and object C for some reason can not be measured directly. Instead, C is viewed from points A and B, and the angles of view with reference to a standard direction are measured. Finally, the length of the base line b must be determined, and with some trigonometry, all the angles and side-lengths of the triangle may be calculated, including the distance between B and C. This geometry is similar to the standard-stereo-configuration of

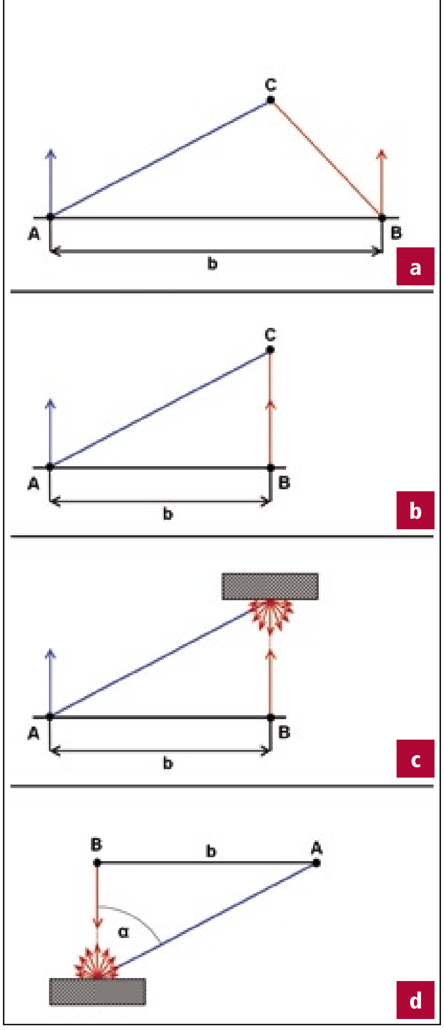

Fig. 1: The principle of triangulation

two cameras with their optical axes running parallel [2]. Figure 1b shows a special case where one line of view is along the reference direction. In a triangulation sensor, this special perspective is replaced by a laser beam shining along this line of view onto a surface. The resulting laser spot serves as the point of interest C, which is viewed from position B and appears under a certain angle. The geometry of this configuration is completely equivalent to the situation in figure 1b. Rotation by 180° results in the set-up shown in figure 1d, traditionally depicted in textbooks and articles to back up the standard-description of a triangulation sensor: a laser beam is directed onto a surface at normal incidence, and the laser spot is imaged onto the detector at the triangulation angle α.

Imaging

Figure 2 explains the optical set-up with the pick-up lens producing an image of the laser spot in the detector plane. The optical axis of the lens is aligned to intersect the surface under examination at the working distance z of the sensor. When the surface is moved along the direction of propagation of the laser beam, the distance z becoming larger or smaller, the position of the image spot in the image plane will move along the detector surface. An image-shift Δx in the detector plane is proportional to a distance-shift Δz, at least in first-order approximation:

$$\Delta x = \beta' \sin\alpha \, \Delta z$$

The magnification β' is determined by the focal length f' of the lens and by the object distance a or the image distance a', respectively:

$$\beta' = (a'/a) = f'/(a+f')$$

The main task within a triangulation sensor thus is to measure the shift Δx of the image of the laser spot in the detector plane with reference to the optical axis. A linear detector array with discrete pixels is well suited and widely used, but a position sensitive device with analog output is a reasonable alternative. The factor β' sinα is constant within a first-order approximation. Deviations from the linear relation between Δx and Δz may be determined by calibration and can be compensated during signal processing. The working range of the sensor, in other words the maximum distance-shift Δz, is limited by the maximum shift Δx of the image spot in the detector plane, which is limited by the length of the linear detector array. The depth resolution is determined by the precision of the position measurement for the image spot. For a linear detector array, one might be tempted to associate the pixel pitch with the uncertainty of the position measurement. When a spot covers several pixels, however, the centre of gravity in principle may be determined with subpixel-precision. Anyway, for a sensor equipped with 1,024 pixels in a linear detector array, a depth-resolution in the order of per mill of the working range is a good guess.

Scheimpflug Rules

When the surface of the object under examination moves along the z-direction, the image will move out of focus in the detector plane as shown in figure 2. The lens will produce a sharp image in the detector plane only for object points in an object plane which is perpendicular to the optical axis. The distance-variation Δz, however, is along the line of propagation of the laser beam, tilted with reference to the object plane of the lens-detector-compound. For a detector plane perpendicular to the optical axes, the image of the laser spot will thus immediately move out of focus and become blurred when the image of the spot shifts out of the central

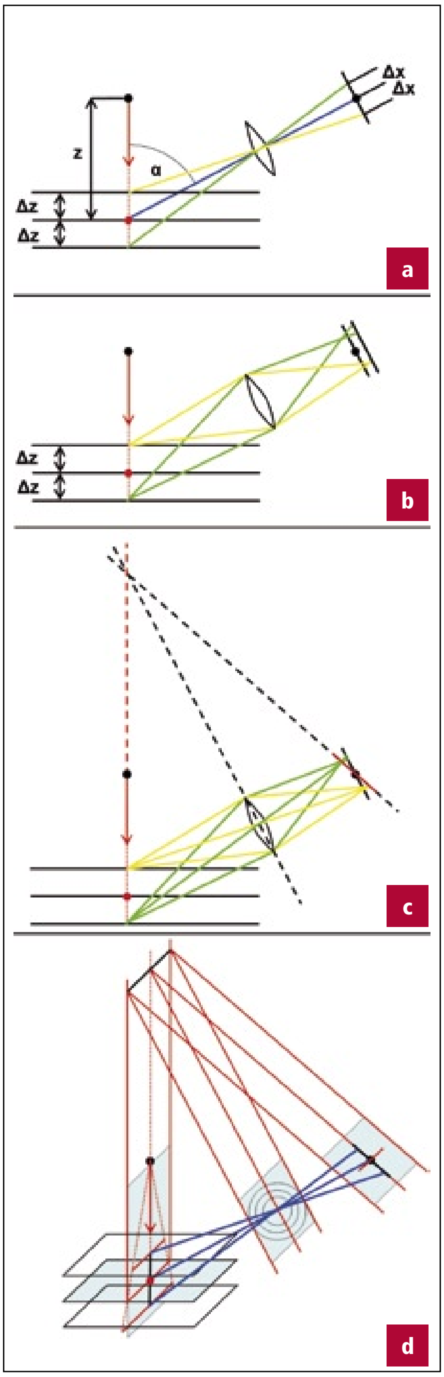

Fig. 2: Optical set-up of a triangulation device. To get a sharp image on the detector array, lens plane, object plane and image plane have to intersect in a single line (Scheimpflug's rule).

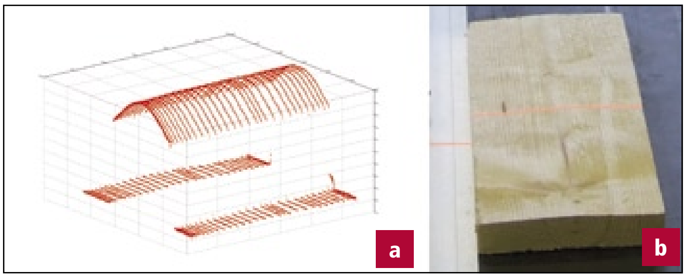

Fig. 3: A measurement with a light section sensor. The object is moved with the direction of motion perpendicular to the laser line. Stacking subsequent profiles produces a 3D-visualization of the surface as a point cloud.

position. Blurring may be compensated, however, by tilting the detector around the central point where the optical axis intersects the detector plane. The tilt-angle is determined by Scheimpflug's rule [1]: lens plane, object plane and image plane have to intersect in a single line or a single point, respectively, as shown in figures 2c and 2d. For a triangulation sensor, the object plane is defined by the laser beam, since every point which can be addressed by the laser beam within the working range should be imaged as a sharp spot onto the detector plane. This consideration easily opens up a well-known extension of the simple triangulation sensor, the light section sensor. Instead of a pencil beam, a light section device projects a laser line onto the surface of the object. Due to the surface topography, the laser line appears to be distorted when viewed at the triangulation angle by a camera with an array detector. The image of the laser line contains the distance information for every single corresponding point of the laser line on the surface of the object. The object plane in accordance with Scheimpflug's rule in this case is defined by the laser line and the direction of propagation of the central beam of the laser projection device. The object plane thus is identical with the plane of the laser light fan. Figure 3 shows an example for a measurement with a commercial light section sensor. The laser line is aligned perpendicular to the direction of motion of a conveyor belt, which moves the object through the line of sight of the sensor. For every light section the measurement results in a surface profile in the plane of the laser fan. The whole contour of the object may thus be probed slice by slice and can be depicted as a point cloud by stacking subsequent profiles.

Further Considerations

For triangulation with a device as sketched in figure 2, a target surface with diffuse reflection is required. To get a signal, the laser beam shining at the surface must in part be scattered into the aperture of the pick-up lens. Shining objects with strictly reflecting surfaces are thus not well suited for this method. The same holds true for dark areas with low remission, which will result in low image contrast and lead to problems with the precise measurement of the position of the laser spot on the detector array. For some materials, scattering does not only take place at the geometrical surface of an object. Certain plastics, e.g., are opaque due to scattering of light which has penetrated the surface and is backscattered by small particles embedded in the material like sunlight being scattered by water droplets on a misty autumn morning. Scattering efficiency may strongly depend upon wavelength. Materials which are opaque in the visible range may well be transparent in the near infrared [3]. The wavelength of the laser beam in a triangulation sensor thus must be carefully considered with regard to the application scenario. For the optical layout, it should be borne in mind that Scheimpflug's rule is just a first-order correction. A lens with strong optical distortion and prominent field curvature will result in additional blurring and further variation of the magnification along the detector array. Perspective warping due to the central projection in standard-lenses will add further problems. Reflections from the background may occasionally enter the pick-up optics, and an additional spot may appear in the image, giving rise to severe problems in discriminating between signal spot and reflection. In general, the laser spot or laser line must show a significant grey level difference to the background. In this context, image processing methods come into play. Algorithms as well as laser beam shaping can be designed to support the robust detection and processing of the laser spot in the image. In addition, optimization of the projection optics is mandatory whenever the lateral resolution limit perpendicular to the distance-shift, dictated by the laws of physics, shall be realized. Extensions of the simple light section principle are sensors based on groups of parallel lines or fringe patterns for illumination.

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Bring Your Avatar to Life

3D Sensors for Interactive Human-Machine Interfaces

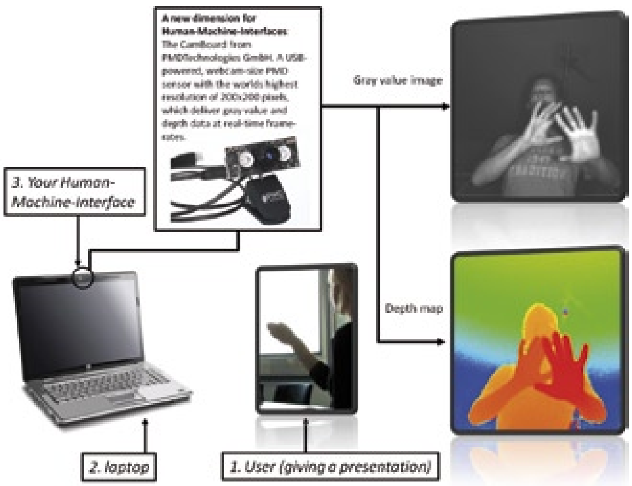
An important presentation: How pleasant would it be to operate the notebook interactively and contact-free, just with pre-defined gestures. What sounds like a futuristic vision is already possible today. 3D image sensors not only detect the user's hands, they also capture human body poses if required. This ability enables completely new interfaces.

3D image sensors from the company PMD-Technologies deliver a 2D gray-value image as well as a 3D depth map. With frame rates of up to 100Hz, the time-of-flight (TOF) sensors detect human body poses. The latest generation of these full-body tracking systems has been presented at the PMD Vision Day on November, 18, 2010 in Munich together with the software company Omek Interactive from Israel. This latest generation enables the gamer to move freely in front of the PMD camera. Controllers or peripheral devices are not needed anymore. The PMD camera provides a depth map of the gamer; every pixel represents a distance value. The tracking software from Omek Interactive utilizes the camera data to identify different body parts and movements in real-time. The movements of the gamer are projected seamlessly on the virtual character – what he is doing, is done in an instant also by his avatar.

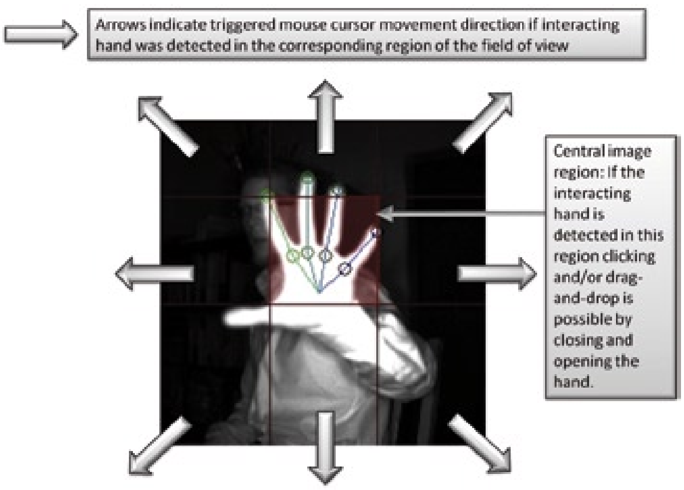
Interaction with the Hands

Nevertheless, the detection of the full body human pose is not the only way to enable a touchless interaction. For a wide field of applications the interaction does not have to be accomplished with the whole body but with the hands. Such applications are for example menu navigation of mobile phones, touchless interaction with a notebook during presentations or in general the usage of interactive control displays when touching a display is difficult due to dirt or even impossible due to the risk of contamination.

The proof of concept to integrate technology into such small devices as laptops or handhelds has been exemplarily verified with the PMD[vision] CamBoard. This prototype demonstrates that by using 2D/3D vision the applications pointed out above can be addressed with a web-



The PMD[vision] CamBoard provides a gray-value image and a depth map at the same time. This opens up a new dimension for people interacting with the world.



Scheme of a human-machine-interface using the PMD[vision] CamBoard: Mouse cursor movement, mouse click and drag-and-drop are possible. The lines and circles indicate the detected positions of finger tips, root finger joints and center of palm.

ONLINE

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

http://en.wikipedia.org/wiki/Optical_illusion

■ According to Wikipedia an optical illusion is characterized by visually perceived images that differ from objective reality. The information gathered by the eye is processed in the brain to give a percept that does not tally with a physical measurement of the stimulus source. There are three main types: literal optical illusions that create images that are different from the objects that make them, physiological ones that are the effects on the eyes and brain of excessive stimulation of a specific type, and cognitive illusions where the eye and brain make unconscious inferences.
What Wikipedia does not say is that optical illusions are a lot of fun. Let´s prove that with some examples.

www.bbc.co.uk/news/magazine-11553099

■ BBC News Magazine presents some mind boggling illusions on their website.

http://mashable.com/2010/08/01/optical-illusions-videos/#view-as-one-page

■ Five more optical illusions with a „whoa" effect.

www.michaelbach.de/ot/

■ A collection of 43 lovingly compiled visual phenomena and optical illusions.

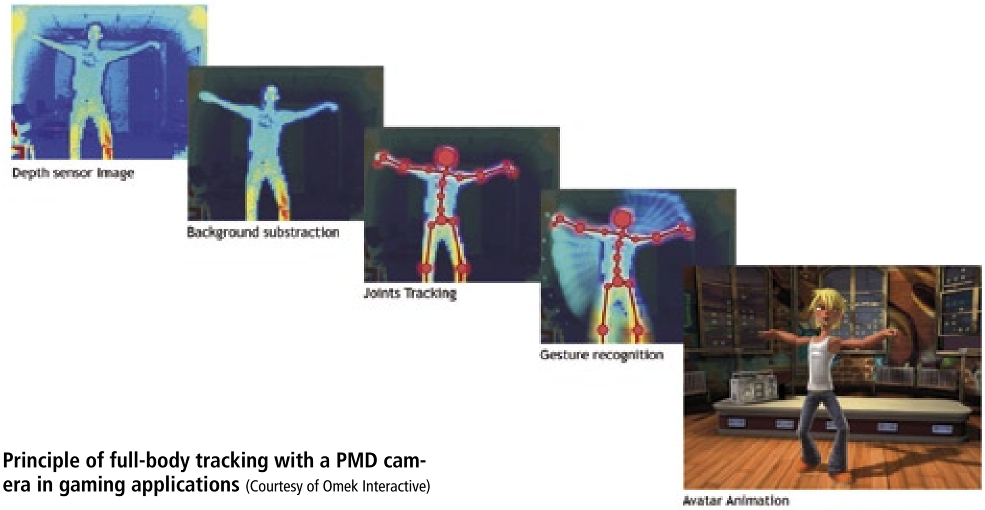
www.optischetaeuschungen-online.de/optischetaeuschungen/optischetaeuschungen.php

■ Optical illusions from the categories of geometry, switch effects, contrast, perspective, and specials.

www.optillusions.com/

■ Here you will find colour illusions, image flips, hidden pictures, weird lines and strange circles, impossible objects, disappearing objects, and some word-based illusions and mind teasers.

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



Principle of full-body tracking with a PMD camera in gaming applications (Courtesy of Omek Interactive)

cam-sized system which is fully USB-powered.

The Method's Advantages

The detection of hand gestures using the gray-value and depth data available from the PMD[vision] CamBoard provides several robust features compared to 2D image based approaches. The depth map measuring is independent from environmental illumination conditions. This means that the 3D data is available in darkness as well as in outdoor conditions. In addition, the rough segmentation of a hand can be accomplished based on the depth data and consequently no texture information is needed to identify the hand. Thus, hands can be detected even when they are covered by a glove or for strongly varying skin colors.

Detecting the Absence

Nevertheless, detecting the hand is only one part of the solution. The absence of a hand performing a certain gesture has to be detected reliably, too. Otherwise, unintended interactions may occur since a hand gesture would be detected although the user did not intend to perform an interaction. Since unintended usage is likely to have a severe effect on the user acceptance it is important to address this issue when designing a human-machine-interface. This issue can be addressed by PMD-based 2D/3D sensors, too: If an object has been detected as a potential hand which should trigger a certain interaction, the analysis of certain metrical features like the length of the fingers or the width of the palm provides a counter-check whether the detected object really is a hand.

Realization in Three Steps

An exemplary human-machine-interface is described in the following. A hand with its palm facing the camera and four outstretched fingers shall be detected as the interacting hand. That means if this hand gesture is detected the system shall enable certain interactions (which can be defined later). If such a hand is not detected the system shall disable all interactions.

The processing pipeline is composed of the following steps:

- **Segmentation of the hand:** Using two distance thresholds to define a minimum and a maximum interaction distance from the camera and additionally exploiting certain anatomical features of the hand, the hand is segmented.
- **Validation of shape features:** By analyzing the shape of the segmented hand, the finger tips, the contour of the palm and the center of the palm are determined. If no four finger tips are detected the hand is not in a valid interaction pose.
- **Validation of metrical dimensions:** Using the information of the previous step about finger tip positions and contour of the palm, the position of the root finger joints is determined. Using the unique feature of PMD sensors that 3D coordinates are available for every pixel the 3D length of each detected finger (the distance from root finger joint to corresponding finger tip) is computed and it is checked

whether the length of the finger is in a reasonable range for fingers of a human hand.

Summarizing: Steps 1 and 2 verify whether the shape of the detected object is in accordance with the shape of an interacting hand. Step 3 verifies that the detailed metrical dimensions of the object are in accordance with those of an interacting hand.

Setting Gestures

Based on the capability to reliably detect the presence or absence of an interacting hand, an HMI providing mouse cursor movement, click and drag-and-drop functionality can be designed in a straight-forward manner:

- **Mouse cursor movement:** The field of view of the PMD[vision] CamBoard is partitioned into 3 x 3 segments. Depending on the segment in which the interacting hand was detected a certain mouse movement is triggered. The central segment triggers no mouse movement.
- **Switching between interaction modes:** The HMI differentiates two interaction modes: A click mode and a drag-and-drop mode. Holding the hand still in the central segment of the field of view switches from click mode to drag-and-drop mode or vice versa.
- **Click:** If the HMI is in click mode and the interacting hand is closed and opened a left mouse click is triggered.
- **Drag-and-drop:** If the HMI is in drag-and-drop mode, the first closing and opening of the hand triggers the pressing of the left mouse button; the second closing and opening of the hand triggers the release of the left mouse button. This effectively emulates a drag-and-drop interaction.

A 2D/3D system in the size of a webcam ensures the detection of these gestures with PMD sensors. The small form factor and the power supply over USB without any additional cables prepares the technology for the consumer market. While more than one year ago, a similar functionality was realizable (see Minority Report – Futuristic Interface-Technology by 3D Image Processing, INSPECT 6-7/2009), the required PMD[vision] CamCube was far larger and not as easy to use. As the consumer industry is known to be a driving force for faster and lower-cost solution, it will be exciting to observe how this fact will change the cooperation between human and robot in the industry.

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One-eyed Vision – Three-dimensional World

Capture of Stereoscopic Image Pairs through a Single Optical Channel


© bricehardelin/Flickr

As automotive safety is an ever growing concern for consumers, the role of machine vision in the automotive industry is rapidly expanding to encompass not only the manufacturing process, but driver-support features as well.

While there are certainly some strictly cosmetic applications for vision technology, including driver recognition and automatic parking, the most useful applications can be found when looking at potential safety features.

Consider, for example, intelligent cruise control, which can keep pace with the vehicle ahead of you without crashing into it. Or similarly, collision mitigation systems that monitor your distance from the cars ahead of you and behind you in order to minimize the potential for a collision. Another application is in blind spot / lane change detectors, which can prevent a driver from changing lanes if there is another vehicle in the way - or if there is another vehicle coming into the lane.

These are all applications that require accurate and timely 3D information in order to determine distances and calculate collision potential.

Challenges of Mass Adoption

With all the potential benefits of such 3D machine vision in automobiles, though, come some serious challenges that need to be addressed before it's a viable technology that sees mass adoption.

One of the greatest challenges to be overcome is finding ways to synchronize and align two or more cameras, and finding ways to ensure they stay aligned.

In creating range maps for automobile distance gauging, for example, one of the first steps is simply registering pixels between images. With a perfectly aligned system, this is an easy task – the pixels will be on the same plane, and so it's a simple calculation to determine distance. If there is vertical misalignment, though, then before any distance calculations can take place, there needs to be corrective measures taken against that misalignment before pixel or sub-pixel matching can take place.

Complicating the Matter

This is a process that can be solved with the right algorithms and enough processing power, though obviously the greater the potential misalignment, the more time and processing power such calculations will require.

Complicating the matter is the simple fact that the external environment will have a variable misalignment effect on any dual sensor system – factors such as temperature and vibration can cause large fluctuations in sensor position, making it extremely hard to predict beforehand. This increases the processing power and time required to determine distances accurately, which can lead to severe problems in an environment where time is a critical factor (such as determining the distance between your car and the car ahead, and determining whether or not the automatic breaking should be activated).

For example, consider areas in which drivers wake up to find winter frosts covering their cars. The morning sunrise alone can cause enough of a temperature differential between two cameras to cause indeterminate misalignment, and driving itself can create enough vibration and impact to cause further misalignment.

Move to a Single Sensor Driver

Canadian company ISee3D has developed technologies aimed to address these issues, allowing for stereoscopic image capture through a single lens to a single sensor. Instead of relying on ever more complex algorithms or computer processing capabilities, ISee3D is addressing the problem at the source, by moving to a single optical channel.

From its inception in the mid 1990's as a producer of 3D endoscopes for use in minimally invasive surgery, ISee3D has focused solely on addressing the issues inherent with dual camera capture in all fields by developing and refining methods to capture stereoscopic images through a single lens, to a single sensor.

A move to single sensor driver support machine vision applications would bring significant advantages. Without needing to correct for potential misalignment, a single sensor system could allow for much simpler pixel registration algorithms, enabling faster and more accurate image pairing.

Single Lens Technology

ISee3D´s single lens technology can be best explained by envisioning a large magnifying lens: look through it at an object and focus the lens. With the lens close to your face open and close each eye to create a stereo pair of images. Looking with both eyes has the stereo pair simultaneously. Now move to another object and change the focus. The focus point becomes the zero parallax plane and everything in front converges. Now with one eye closed or covered, keep the lens stationary and move your eye from the left side of the lens to the right side and objects in the foreground will move more than objects near the infinitely plane. It should be noted that your eye or the lens can move and create the same images. Placing this left – right optical switch in a "pupil" location in a lens system provides a full field left and right natural 3D view. The focus setting of the lens sets the zero parallax location and everything closer than that focus plane will appear in front of the screen, while everything behind the focus plane will appear further away. This allows a lens to provide excellent and natural 3D images from close up to distant views.

Applications Reaching Far Beyond

Naturally, the benefits of a single sensor approach to stereoscopic image pairing have applications reaching far beyond driver-assistance machine vision. Many applications which currently use dual optical channels to generate stereoscopic image pairs benefit from the stability offered by a single lens approach. ISee3D engages in licensing agreements with firms to develop products incorporating its single lens, single camera 3D technology.

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Surface-based 3D Matching

A Software Tool for Working with 3D Point Clouds

Surface-based 3D matching is an innovative software technology for finding the pose of an arbitrary object in a 3D point cloud. The method shows its strength especially for rounded and rather edgeless objects even with polished surfaces, which are typical in metal processing. The surface-based 3D matching is characterized by speed, accuracy, and flexibility. This allows an easy and stable implementation of conventional and novel applications.

3D Vision Gaining Ground

Three-dimensional machine vision (3D vision) is currently gaining importance for several reasons. One reason is the availability of low-priced and stable 3D scanners that produce accurate, high-resolution 3D point clouds with high frequency. Another reason is the availability of intelligent software for processing such data. The advantages for users include shorter development times, stable methods, as well as inexpensive and flexible setups with standardized hard- and software. This allows the use of machine vision in domains with requirements that are by far out of reach for classic 2D vision, such as checking for completeness in 3D, bin-picking, picking of arbitrarily oriented objects from a conveyor belt, depalletization, or 3D tracking.

A typical 3D point cloud acquired with a laser scanner. The cloud shows clutter in form of a background plane, missing data, and occlusions.

3D Object Detection

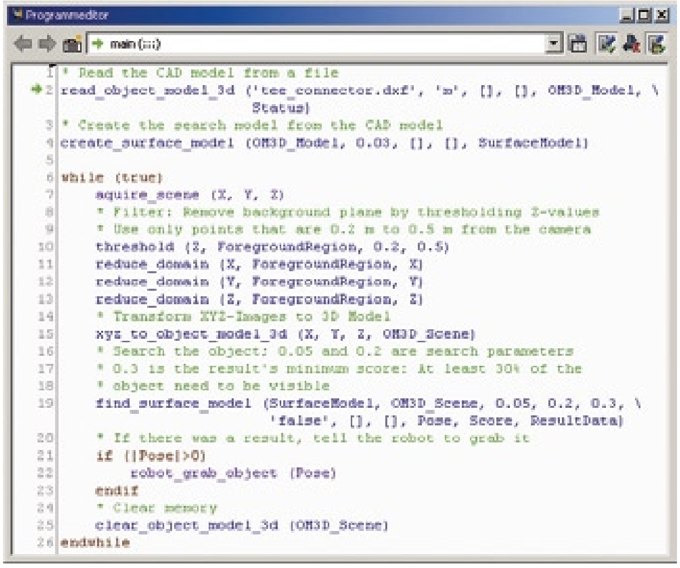
Similar to 2D vision, a crucial step after the acquisition of a 3D point cloud is the detection of objects and the determination of their pose. This allows subsequent inspection or manipulation of the objects. For classic 2D vision, a number of off-the-shelf operators exist that can deal with arbitrary search patterns, e.g., gray-value or edge-based matching. 3D vision, however, so far often required specially developed solutions that were programmed for one specific, fixed kind of object and only able to detect this. The newly developed surface-based 3D matching of Halcon 10 is a universal standard solution for 3D vision that allows the detection of arbitrary objects in 3D data.

The method is extremely flexible: Arbitrary 3D free-form objects are possible as reference model and can be passed either as CAD model or as 3D reference scan. The latter allows a particularly easy and fast learning of new objects: The user only needs to acquire the model once with any 3D sensor and can then immediately find it in other scenes - without the need of a time-consuming modeling. This also allows applications to learn new objects online.

Stable against Noise and Occlusion

Surface-based 3D matching was designed for industrial applications and is stable against noise in the 3D data, against clutter, against missing object parts due to occlusion or sensor problems, and against small variations of the object's shape. The object is found without restrictions in any 3D position and orientation; no approximate pose needs to be given. Also, multiple instances of the object can be found in one single call. The search times are in the range of few tenths of a second.

The 3D point clouds of the model and the scene can come from any 3D sensor, such as stereo systems, time-of-flight cameras, sheet-of-light setups, depth from focus, depth from shading, and others. The acquisition of the data and the calibration of the sensors are directly done in Halcon. The 3D point clouds are typically provided in three images which contain the X-, Y-, and Z-coordinates of the 3D points. The transformation of the 3D coordinates into such range images has the advantage that a large number of classic 2D filters integrated in Halcon can be used to pre-process the data. Such pre-processing includes, e.g., smooth-



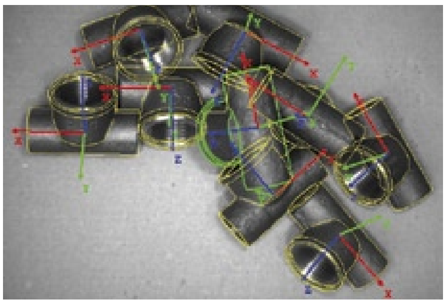
```
Programmeditor
main (:::)
* Read the CAD model from a file
read_object_model_3d ('tee_connector.dxf', 'm', [], [], OM3D_Model, \
                      Status)
* Create the search model from the CAD model
create_surface_model (OM3D_Model, 0.03, [], [], SurfaceModel)

while (true)
    aquire_scene (X, Y, Z)
    * Filter: Remove background plane by thresholding Z-values
    * Use only points that are 0.2 m to 0.5 m from the camera
    threshold (Z, ForegroundRegion, 0.2, 0.5)
    reduce_domain (X, ForegroundRegion, X)
    reduce_domain (Y, ForegroundRegion, Y)
    reduce_domain (Z, ForegroundRegion, Z)
    * Transform XYZ-Images to 3D Model
    xyz_to_object_model_3d (X, Y, Z, OM3D_Scene)
    * Search the object: 0.05 and 0.2 are search parameters
    * 0.3 is the result's minimum score: At least 30% of the
    * object need to be visible
    find_surface_model (SurfaceModel, OM3D_Scene, 0.05, 0.2, 0.3, \
                        'false', [], [], Pose, Score, ResultData)
    * If there was a result, tell the robot to grab it
    if (|Pose|>0)
        robot_grab_object (Pose)
    endif
    * Clear memory
    clear_object_model_3d (OM3D_Scene)
endwhile
```

Program code for surface-based 3D matching. First, the CAD model is read from a file and the search model is created. In the main loop, the 3D point cloud is acquired as XYZ image triple, the background plane is removed by thresholding the Z-image, and the object is searched in the scene.

ing using filters for noise suppression and the removal of background from the point cloud by reducing the region of interest (ROI) of the images. The orientation of the images is irrelevant, since they only contain the 3D coordinates.

Simple Training of the Objects

The search model must be trained only once in the offline phase, which takes a few seconds. For this, the 3D point cloud of the model is passed to an operator. The matching is done automatically in two phases: First, the approximate positions of the object in the scene are determined. This is done by selecting pairs of points from the scene point cloud and searching for correspondent point pairs on the model surface. As soon as enough correspondences are found, the 3D pose of the object can be reconstructed. All approximate poses found in that first phase are then refined using a highly precise and stable least squares method.



Result of the surface-based 3D matching on a 3D point cloud acquired with a multi-camera stereo setup. Multiple instances of the object were found with a single call to the matching operator.

Surface-based 3D matching returns the object poses in the camera coordinate system as well as a quality measurement for each found instance. The reference model can then be compared with the scene to detect defects or missing parts. Also, using a hand-eye calibration, the object can be picked. Thus, surface-based 3D matching allows to solve problems that are hard to impossible to tackle with classic 2D vision. This, in turn, unlocks new applications and markets for example in the robotics and automotive industry.

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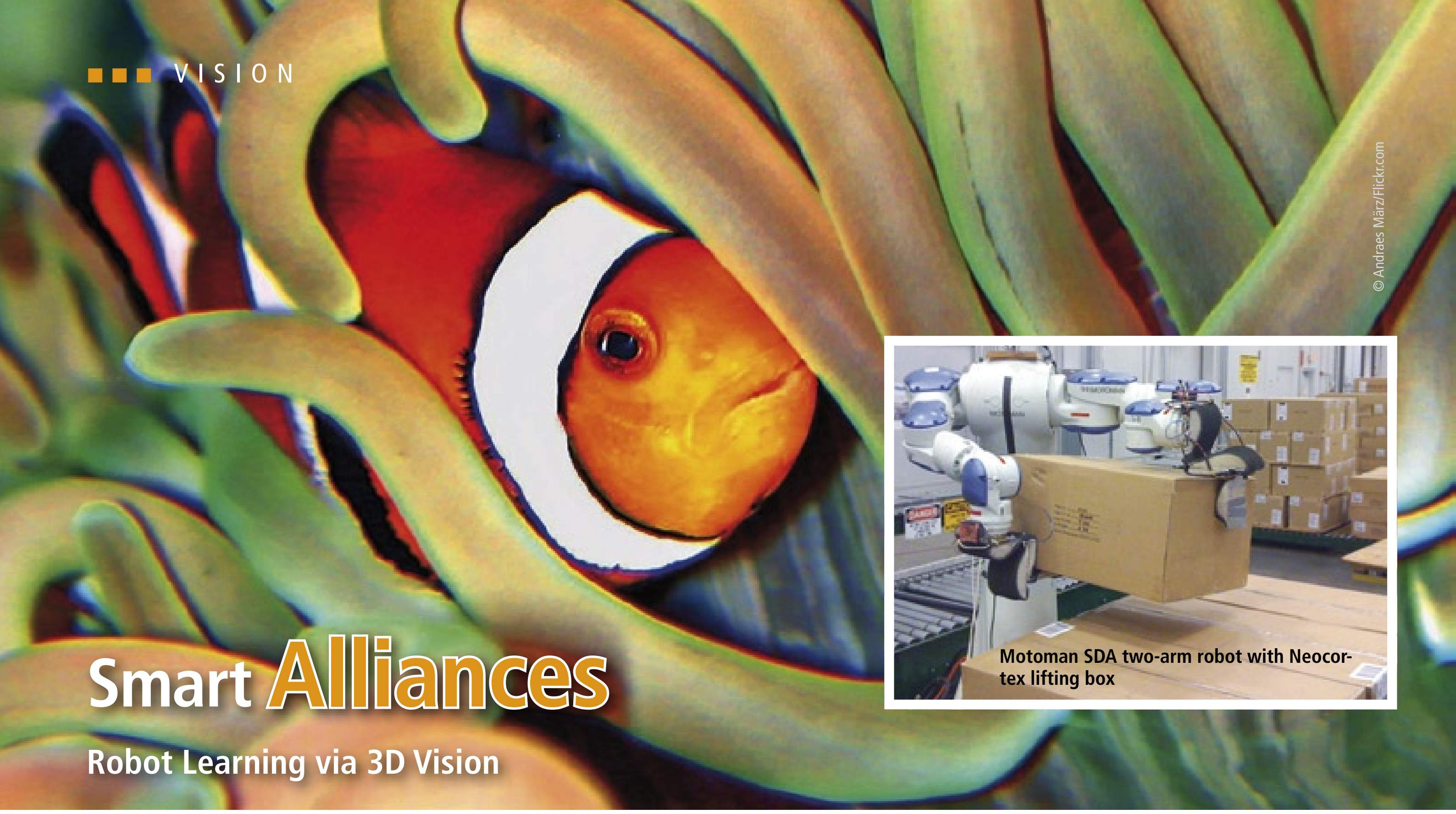

Motoman SDA two-arm robot with Neocortex lifting box

Smart Alliances

Robot Learning via 3D Vision

Traditionally, machine vision or Automated Optical Inspection (AOI) systems have helped produce quality mass manufactured products. These systems provide visual feedback and analysis to very structured processes through filtering, pattern matching, histograms, edge detection, matching shapes, patterns and colors, and taking measurements. Through the use of highly accurate equipment, structured lighting, custom mounting, and extensive programming, a 2D/2.5D/3D vision system is able to play a key role in quality control by recognizing a good product and rejecting a bad one.

New Role for 3D Vision

3D vision systems are playing an essential new role in the field of robotics and are enabling the automation of tasks that have been impossible to automate previously.

Universal Robotics created novel software called Spatial Vision that turns any pair of webcams into a cost-effective and easy to calibrate and install 3D vision system. Spatial Vision was created during the development of Neocortex, a sensory-motor based form of artificial intelligence that enables robots to learn from their experiences and perform tasks that are unsafe or difficult for humans. Through more than 50 channels of sensor data, Neocortex allows a robot to observe its environment and change its actions as necessary in real time to complete a given task.

A Neocortex-enabled robot's sensory data is not just time stamped, but also stamped with 3D vision data. Vision capabilities for this robot include traditional requirements – filtering, pattern matching, histograms, edge detection, object recognition, and measurement taking – as well as real-time 3D positional information blended with multiple modes of sensor data. This enables the robot to react to unexpected changes in the environment, the task, or the object of interest.

While Neocortex has applications in many fields, from underwater mining to bomb diffusing, it has been initially rolled out in the materials handling market, being used as an automated mixed-size box handler. Universal Robotics partnered with Yaskawa/Motoman Robotics to provide a hardware/machine intelligence work cell solution that features

Table 1

Horizontal Resolution (mm) at Camera Distance of 2.0M (6.1 ft)						
Camera Resolution:	MPx	HORIZ Px	VERT Px	Camera Optics -100%	SW at Best Calibration - 80%	SW at Normal Calibration - 60%
CIF	0.1	352	288	7.0	8.7	11.6
VGA	0.3	640	480	3.8	4.8	6.4
HD 16:9	0.7	960	720	2.6	3.2	4.3
SXGA	1.3	1280	1024	1.9	2.4	3.2
UXGA	1.9	1600	1200	1.5	1.9	2.6
HD 1080	2.1	1920	1080	1.3	1.6	2.1
4 MPx	3.9	2288	1712	1.1	1.3	1.8
5 MPx	4.9	2560	1920	1.0	1.2	1.6
8 MPx	8.0	3264	2448	0.8	0.9	1.3
Assumes Horizontal AOV =63 deg; Vertical AOV = 49.5 deg				Horizontal Accuracy (Pixel Size in mm)		

Neocortex software, Motoman's SDA-series robots, custom box moving end effectors and a suite of sensors, including Spatial Vision.

3D Accuracy Required for Two-Arm Robots

In contrast to AOI often being sub-pixel, Spatial Vision's 3D accuracy is based on the pixel resolution of the camera, which allows the selection of the low cost equipment to do the job.

What's required for a two-arm robot to move boxes? In a work cell for a two-arm robot that is about 9 ft in diameter, a pair of cameras would be installed roughly 4–6 inches apart 4 ft above the work area, making the maximum distance from the cameras to the furthest point in the work cell about 6 ft (2 m).

In the chart below, the first row in bold at camera resolution of HD 16:9 with the Logitech 9000 webcams, is what Universal Robotics currently uses for box moving at a depalletization work cell, resulting in 3D resolution of 3–4 mm. With the new Logitech C910 webcam, the second bold row marked HD1080 shows the resolution doubles in accuracy to 1.5–2 mm.

The first colored column shows the horizontal pixel size of the camera optics, or its potential error. The second column shows what Universal Robotics has found is the best possible software resolution based on the best calibration practices. If a user doesn't follow Spatial Vision's calibration wizard and guidance, normal calibration practices typically result in only 60% of the optical resolution.

Learning in an Unstructured 3D Environment

For AOI, very precise visual capabilities are required in order to detect components as small as 50 µm. AOI is also appropriate for assemblies or products that are geometrically precise, have visual characteristics that can easily be measured within specifications, and always vary in ways that can be pre-programmed.

But what if the objects of interest vary with no particular pattern? In the example above, shipped cardboard boxes vary with no particular pattern – many times they arrive dented, damaged, bulging, or worn – all for one identical SKU (Stock Keeping Unit). This is why box moving has not been automated previously. Secondarily, automating a task for the two-arm robot requires the combination of multiple sensor modalities. This shifts the complexity and intelligence from the specialized hardware and sensors to the parallel processing of many generic sensors such as vision, touch, force, infrared, etc., lowering the cost of automation.

Accurate industrial 3D vision systems typically start at US$ 10,000 and can easily exceed US$ 50,000. However, you can buy a USB 2.0 HD (1,920 x 1,080) video webcam that records 1,080 p

Table 2:

Task	Task Time	Sensor Type	3D Spatial Resolution
Identification of boxes, pallet orientation	5%	Pair of webcams	< 4-5 mm
Box moving strategy	10%	NA	NA
Identification of box edges	5%	IR & end effector camera	< 1mm
Path planning	30%	NA	NA
Grip box	20%	Touch flex sensor, force	~ 0 mm
Move box to conveyor	30%	Pair of webcams	< 4-5 mm

Depalletization Task: 100%

at 15 fps and 720 p at 30 fps for under US$ 100 (see Logitech HD Pro Webcam C910). With USB 3.0 becoming mainstream and offering 10 times the throughput (speeds up to 5 Gbps compared to USB 2.0's 480 Mbps), you will be able to get even more data to the PC through inexpensive USB cameras. With massive parallel processing becoming prevalent (see Nvidia's CUDA parallel computing architecture), the PC's ability to deal with higher computational needs in real-time at a low cost is becoming a reality. The recently-released Spatial Vision Robotics enables fast 3D calibration with a pair of webcams, the calibration of a robot work cell and the correlation of the two with no programming at a fraction of the typical cost.

How Well Does It Work?

Prior to running, a Neocortex-enabled robot records the dozen or so possible ways to pick up any box and then uses these methodologies for any box it encounters up to its payload maximum of about 75 lbs. By providing just the right sensor where needed along the task, the robot is able to take advantage of the visual resolution as needed while keeping the complexity to a minimum. Once the robot is conducting the task, the accuracy and time spent is summarized in the table.

This depalletization solution using Neocortex, Spatial Vision Robotics, and a Motoman SDA robot just exited Alpha stage testing at a customer site moving 3–4 boxes per minute, and is speeding up to 6–8 boxes per minute prior to Beta testing at a major US commercial distribution center, delivering a return on investment of 18–24 months.

A Whole New Field Is Opening

3D vision is on the cusp of a whole new field as it moves from part placement on the assembly line to broad applications in unstructured environments like visual analytics, people tracking, security, new applications for automated robotics, filming, and other areas. Precise 3D positioning embedded in smart cameras and used with automated systems in conjunction with other types of sensors can provide a rich understanding as an environment changes in real-time and the object of interest is in motion.

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GigE Vision Capability for Sony FCB E Cameras

GigE Vision and GeniCam standards committee member, Stemmer Imaging, is delighted to be able to announce the versatile performance of the new Sony FCB E Series of color block cameras with GigE Vision and GeniCam functionality. The new CVC GE family includes a camera equipped with an FGI GigE Vision-compliant interface board produced by Stemmer Imaging and the CVB CameraSuite software development kit. Sony FCB E Series color block cameras offer outstanding performance, including true progressive scan from an HAD CCD image sensor. The camera range features zoom lenses from an industry-leading 36x down to 28x or 18x, combined with 12x digital zoom to bring enhanced versatility.

Stemmer Imaging Ltd · Tel.: +44 1252 7800 00
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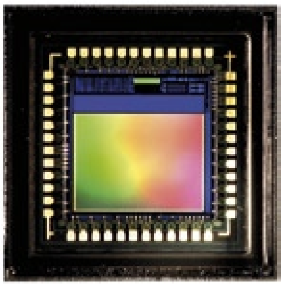
High Speed Solution for Digital Still Cameras



Aptina announced the newest addition to the company's growing portfolio of high-performance image sensors. The 14 megapixel (MP) MT9F002 image sensor integrates the company's latest Aptina A-Pix pixel technology, resulting in an increase of nearly 25% in low-light sensitivity (CCD-equivalent), and providing greatly enhanced, high-quality still image capture over the company's previous 14 MP image sensor. The high-speed MT9F002 sensor combines an enhanced 1.4-micron pixel with advanced features, such as electronic image stabilization (EIS), and digital re-sampling. The new sensor also has full HD (1,080 p/60 fps) video capability, and flexible, high-speed interface options, including four-lane HiSPi (high-speed serial pixel interface) and parallel or four-lane MIPI.

Framos GmbH
Tel.: +49 89 710667 0 · info@framos.de · www.framos.de

Free Programmable Smart Camera

Imago Technologies introduces the new VisionCam XS. The camera uses sensors from WVGA up to SXGA resolution or a 2k line sensor together with a Da Vinci processor from Texas Instruments. All the functions of the camera are covered in a C library and an example program. The developer can start directly to program his application. The VisionCam XS addresses the large market of special applications with the added value of the customer program inside. And if the camera does not fit into the application Imago can offer the "big brother" named VisionCam PS: LinLog high dynamic sensors with high resolution, optional 3D functionality and more processor power are able to offer high end application in form of a camera.

Imago Technologies GmbH · Tel.: +49 6041 968 672
info.itf@imago-technologies.com · www.imago-technologies.com

Detect Minor Defects on Different Surfaces

The new Surface Inspection System EyeSis of EVT offers the user a compact system with an integrated software. The system is especially suitable for the surface inspection of aluminum, plastic, paper, glass as well as other materials. EyeSis is employed where a high-quality appearance is required. The ready-to-use system detects scratches, cracks, dents, rust, inclusions as well as impurity on test components without any problems. The parametrization of the system is as simple as already known by the EyeSpector systems. The system can be configured with a golden part in only a few steps. After configuring the checking is effected autonomously and without a PC.

EVT Eye Vision Technology GmbH
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43.3 mm Line Scan Lenses

Kowa expands its wide portfolio of lenses for industrial vision applications by a new „large format" series for 43.3 mm sensor size. The new LF-Series includes three different models with focal length of 28 mm, 35 mm and 50 mm. All lenses are optimized for extra high resolution and contrast from the center to the edge with only little distortion. Due to a minimum focusing distance of less than 30 cm all three models are suitable for close-up applications

Kowa Europe GmbH
Tel.: +49 211 179 354 29 · lens@kowaeurope.de · www.kowa.eu

HC Cameras for High Speed Color Acquisition

Dalsa launched a new series within its Genie line of affordable, easy-to-use, GigE-Vision-compliant cameras. The Genie HC Series is built for high speed color acquisition with uncompromised image quality. Typical applications for the Genie HC series include electronic manufacturing inspection, intelligent traffic systems (ITS), and food inspection. Additional features include global electronic shutter with exposure control and on-board flat-field correction to produce crisp, clear images. The GigE Vision camera acts as a single machine vision component – integrating both advanced camera and board image acquisition technologies in one small package.

Dalsa
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Ruler of Diversity

3D Machine Vision Accelerates Wheel Production

Wheels for roller coasters, for military vehicles or supermarket trolleys: These various forms of wheels are to be picked up by one robot and then fed to the corresponding processing machine. A task for 3D machine vision, believes Thor Vollset, founder and CEO of Tordivel, which is solved by using smart cameras, says Myriam Beraneck of Sony. INSPECT spoke with both to discuss the technology's role in delivering more accurate automation systems.

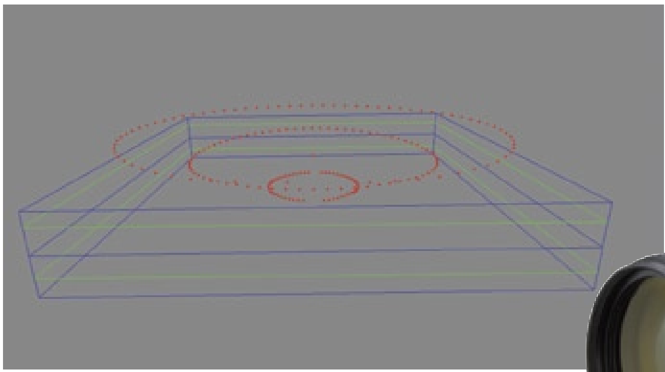
The company Stellana, a major industrial manufacturer headquartered in Sweden, designs wheels for use in a wide range of applications, such as military vehicles, roller coaster carriages, forklift trucks and supermarket trolleys. The company designs a huge array of products, each with subtle variations in, for example, diameter; depth; tread type and fixings, which makes it difficult to quickly sort. Tordivel, the company behind the Scorpion Vision software suite, has recently completed a 3D automation project for Stellana. Tordivel's CEO, Thor Vollset, describes the challenge: "Stellana produces between 30 and 40 different wheels types in a production batch and these products are placed randomly on a conveyor line. Using an automated robot to select the appropriate wheel, read its product ID and place it in the machining tool would significantly cut costs."

The Sony GigE camera ensures rapid data transport in the vision system

Sorting with 2D or 3D?

Vollset started the project using a Scorpion 2D system. This required a far more labor-intensive teaching process, however, and it quickly became apparent that this model was not able to determine all the information necessary and reliably gauge the type of wheel being scanned. Upgrading to a 3D vision system solved these problems. Vollset explains: "In the 3D system all dimensions – radius and heights – are measured in millimeters. This makes the system easy to understand and the data from the CAD drawings can be entered directly into the system when defining the sorting criteria." He is convinced that the majority of machine vision projects place an emphasis on small physical size, accuracy, reliability and "naturally, cost is an important factor too," Vollset continues.

A screen shot from Scorpion Vision's 3D camera as it takes a picture of the wheels


A computer model of the 3D wheel

The automation solution comprises two stereoscopically linked machine vision cameras; one of them is a Sony Smart Camera

Usage of a Smart Camera

He illustrates the operating mode of the automation solution: "The Stellana system utilizes two stereoscopically linked machine vision cameras. Scorpion Vision software is used to analyze the data and the precise three dimensional location is used by an ABB robot to pick the wheels. We used a smart camera from Sony, which has an integrated FPGA processor and thus eliminates the need for an additional PC. This not only cuts down significantly on cost, it also allows you to more easily work within the space constraints demanded by a given project."

Myriam Beraneck of Sony's Image Sensing Solutions division backed this up: "In many ways smart cameras are now fast computers with a high quality integrated video camera; rather than the other way round. Having an on-board processor cuts a rate-limiting step, transmitting data and therefore analysis time drops too. Typically, just a few kilobytes of data are needed for an automated system, such as a picking robot, so having the hardware to transmitting up to 90 frames per second also adds to the cost of a given project." According to Beraneck, the concept of smart cameras has changed in the few years since they were first launched. Instead of a fixed function, which was only commercially viable for mass-market applications, an open platform is now used. Unique programs can now be developed for a plethora of applications, giving an edge in even the most niche of business sectors.

Modern smart cameras are getting faster too. The XCI camera range from Sony, for example, uses a 1 GHz processor and has 512 MB of high bandwidth DDR2-SDRAM. Sony says its customer feedback surveys suggest a three-fold improvement in performance over past generations, making it more than capable of 3D image analysis.

Second Camera: GigE

The second camera in the stereoscopic system is a GigE camera module from Sony. Sony's range of GigE vision cameras has devices delivering up to 90 frames per second or 5 mega pixels. This quality, coupled with the fast data transfer speeds – the units transmit uncompressed image data at 1,000 Mbps – and the module's small footprint made the device particularly applicable to the Stellana project's needs.

3D Systems on the Way up

Stellana went live with the 3D automation system during the first half of 2010. "The benefits of measuring in three dimensions have been clear for many years and we're now at the turning point where the accuracy is proven and the cost is low enough for 3D vision systems to take off in many sectors," said Vollset, who believes the applications of 3D machine vision analysis are limited only to the imagination. Indeed, new applications are being rapidly developed by a number of organizations. One recently promoted example is a 3D medical scanner that measures changes in inflammation over time to assess the onset of rheumatoid arthritis.

Such is the uptake in automation systems based on 3D images that Tordivel now runs training courses on this. And Vollset says there are three key steps that need to be taken when developing an accurate 3D system for analysis: "Data quality is only as good as the images used, so a high quality camera is essential. Real time systems also require fast processing times so a good computer and simple, effective algorithms are needed. Lastly, people have to use it so a clean user interface is essential."

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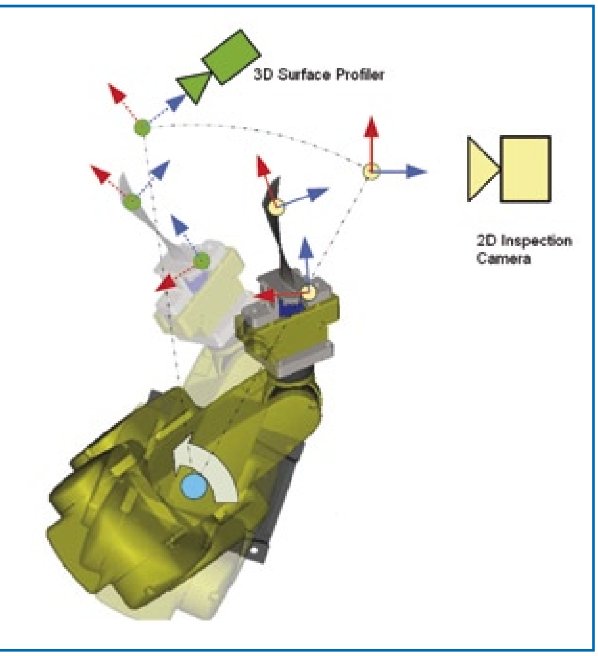
Step-by-Step towards Success

Combined Techniques for Efficient Inline 3D Surface Profiling

When we talk about 3D techniques in machine vision, we generally think about dimensioning as GD&T (Geometric Dimensioning and Tolerancing). 3D scanners are designed to acquire this dimensional information with great speed and good precision in order to verify the overall integrity of the part. However, in industries such as specialty faucets for consumer goods where the appearance of the part is critical, these parts also need to be inspected for random surface defects as nick, scratch, dent and pits. These defects can have a functional impact or can be only aesthetical. The criteria to determine if the part with these defects is to be rejected are related to precise information about the shape and the depth of each defect.

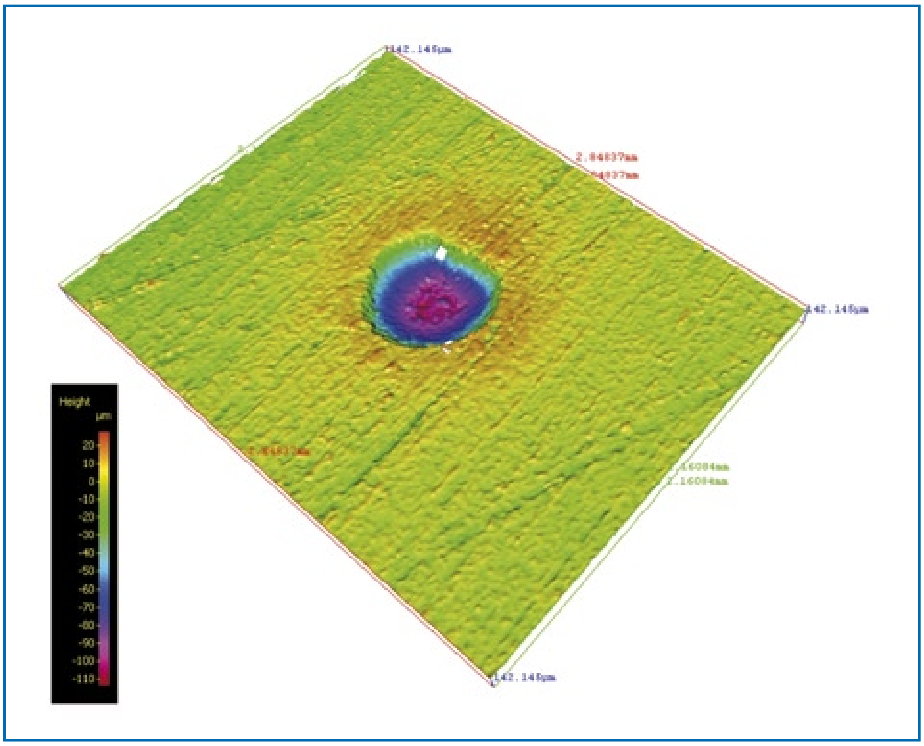


Dynamic path generated to bring the defective area from the 2D camera in front of the 3D device, avoiding any collision of the robot and the part

In manufacturing, these surface defects can start to be a concern in the range of 100 µm diameter and 25 µm in depth. The rule of thumb is then to use a technique with 10 µm lateral resolution and 2.5 µm depth resolution. To evaluate these defects with good resolution and precision, 3D scanners are not precise enough. Another category of 3D devices, 3D surface profilers, are then needed. These techniques work at very high resolution but smaller field of view than the 3D scanners. Hence the scanning of large surfaces can rapidly become very time consuming.

A complete visual inspection of components must be performed on the parts to evaluate if any random defects are present. The inspection cycle time must not exceed the manufacturing cycle times. Taking into account the mentioned specifications, none of the 3D scanning techniques alone can fulfill the needs; a 3D scanner does not provide the precision for analyzing the defect and the 3D surface profiler does not operate fast enough to provide a complete inspection.

But two interesting observations come to light regarding such random defect inspection: 1) there is very low ratio of de-



Example of surface scanning for a dent using a 3D surface profiler

fective surface compare to good and normal surface on inspected parts, so the entire surface of the part needs to be scanned and 2) the defects have enough visual contrast to detect them in an automated fashion using regular cameras. Considering this, AV&R Vision & Robotics Inc. combines a strategy of using a fast 2D image analysis to find the defects and a slower but very precise 3D surface profiling technique to determine the characteristics of these defects.

In a field-proven solution, AV&R is using a 6-axis robotic system to handle the parts. This gives the maximum flexibility for all the required points of view. A complete 2D surface inspection is then performed first to quickly identify suspicious areas. Each time such an area is found, it is located on the CAD model of the part. The transfer of this defect from the 2D image to the 3D CAD gives the position of the defect in relation with the robot world coordinates.

The robot then automatically moves the part to locate the suspicious defect in good position and orientation to be imaged by the 3D surface profiler. A local characterization of the defect with high precision is taken, determining if the suspicious area is really a defect and what is its severity.

By combining the strengths of two different technologies, AV&R has been able to provide a solution where there is no single technology available. In the future, as 3D scanners and profilers become more powerful and faster, it may be possible to use these devices to cover the full inspection requirements that are being driven by today's manufacturing.

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Attraction in Hollywood

3D Sensors Bring Interactive Animation to Guinness World Record Museum

© Tom Hawk/Flickr

Each year, millions of tourists visit Hollywood Boulevard in Los Angeles. The street offers plenty of attractions: museums, restaurants, theaters, big, glitzy stores, and the occasional celebrity sighting. To catch the attention of passers-by on this busy thoroughfare, the Guinness World Records Museum has unveiled a new interactive, outdoor display that uses TYZX 3D vision cameras, a video game engine rendering 3D characters, and sophisticated software to create an eye-catching, interactive show for pedestrians.

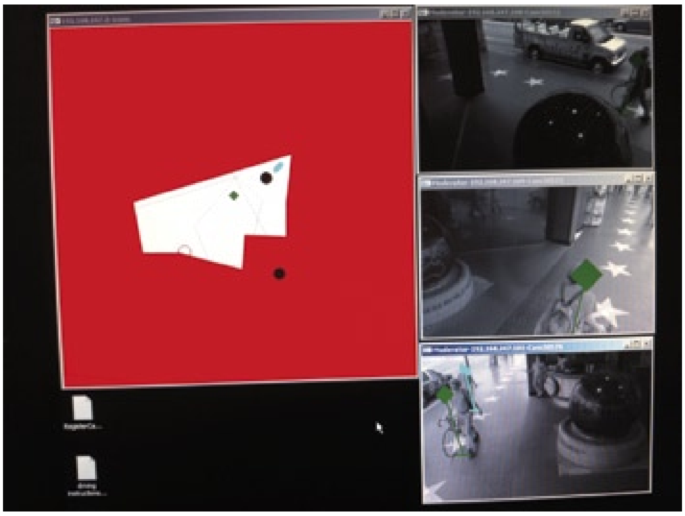
The new installation was designed and built by Electroland, a design team that creates large-scale, site-specific, public art experiences. Electroland's work has been featured at the Museum of Modern Art in New York and the Cooper Hewitt National Design Museum.

The Electroland installation at the Guinness Museum uses three TYZX DeepSea G3 Embedded Vision Systems (EVS) and TYZX PersonTrack software to detect and monitor the position and movement of pedestrians in a 10m by 7m "detection area" along the front of the museum. Each EVS is an intelligent, self-contained 3D sensor solution that uses stereo vision to track the size and location of people and objects in real time, even in challenging lighting conditions. The PersonTrack software enables the Electroland installation to track pedestrians and react to their movements.

Along the front wall of the museum, Electroland installed a 3 x 4 matrix of Planar Clarity Matrix LCD screens, roughly 3m wide by 2.5m tall. In response to tracking data from the PersonTrack application, the LCD screen displays sophisticated 3D avatars – the type of human figure that appears in advanced video games – performing some action or stunt related to a Guinness World Record.

Damon Seeley, a partner at Electroland, explains that the goal is to catch the attention of passers-by and entice them into visiting the museum. The interactivity of the system, along with the drama of avatars performing tricks such as juggling chainsaws or throwing basketballs, is sure to persuade many pedestrians to slow down and give the museum a closer look.

One of the major engineering challenges of the project was to find a real-time camera system that would reliably report range data on crowded sidewalks, regardless of lighting conditions and weather.



The TYZX PersonTrack Control screen with images from all three TYZX systems. The system is tracking the location of passers-by; each person is represented by a solid line and a colored shape covering their head.

The interactive system projects avatars, e.g. a man juggling chainsaws, on the wall of LCD panels.

"The TYZX G3 EVS is far better than other camera systems we've used," said Seeley. "It's fast, accurate, and reliable. Because the system is small, fan-less, and low-power, we're able to install it in tight spaces and have it track people and objects in a large area. TYZX makes it possible for us to bring a new type of theater and technology to the international audience strolling down this famous street."

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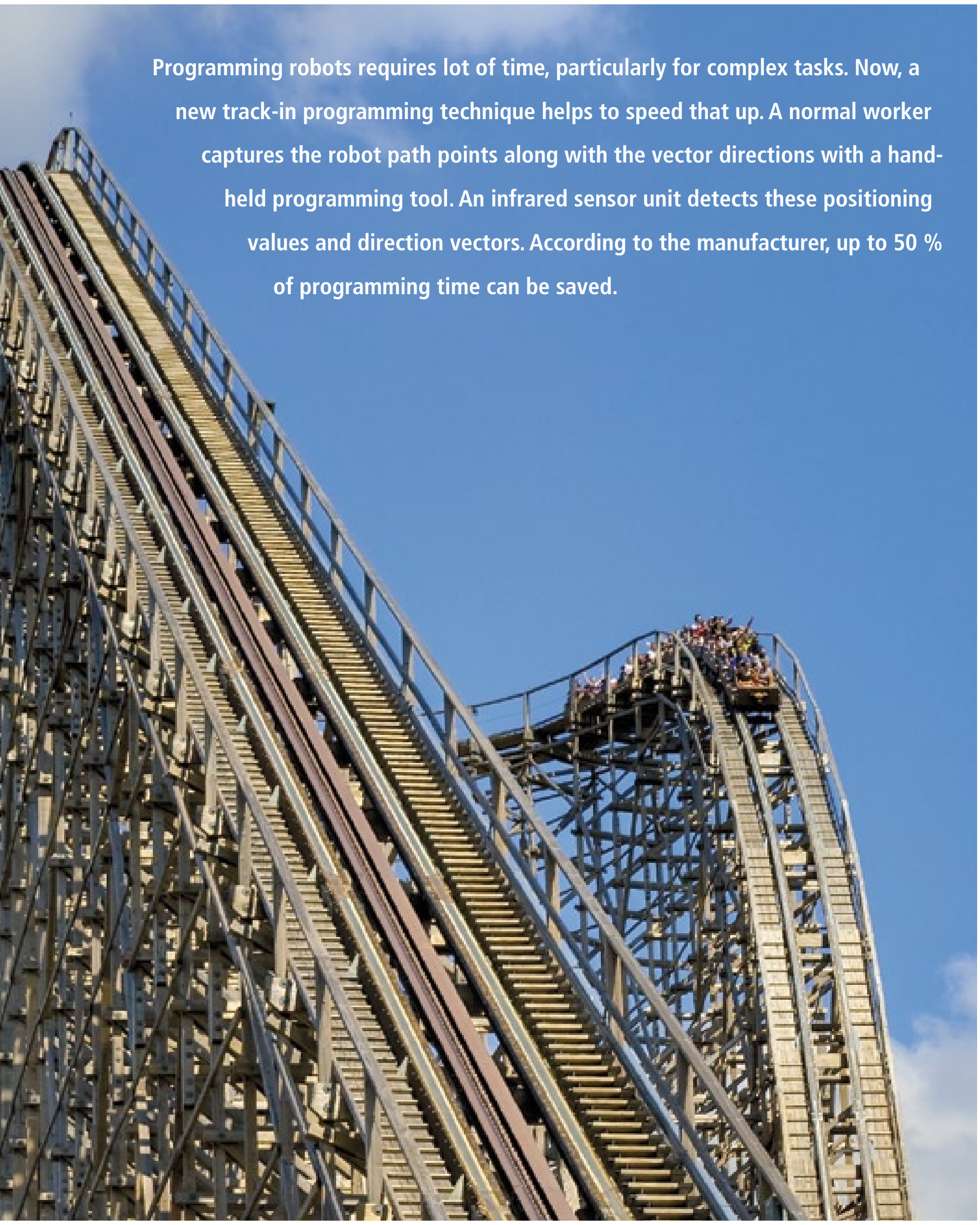
On a Given Path

Track-in Programming Tool with Infrared Sensors

Programming robots requires lot of time, particularly for complex tasks. Now, a new track-in programming technique helps to speed that up. A normal worker captures the robot path points along with the vector directions with a hand-held programming tool. An infrared sensor unit detects these positioning values and direction vectors. According to the manufacturer, up to 50 % of programming time can be saved.



The company RevXperts has developed a new way of programming robots: the track-in process. Thereby, the robot programming can be done online by means of freely moving 6D programming tool that directly takes the base points of the robot path. In addition, with the hand-held programming tool the dimensions of the work piece and the fixtures are digitized and converted into a CAD format. These digitized coordinates and vectors can be used for simulation and optimizing the current process flow and for use in the CAD models for further disposal. These new method closes the gap between online programming with the joystick on the real part and the CAD data based virtual offline programming.

The simple and ergonomic handling of the freely moving 6D programming tool helps especially for complex tasks to save time and cost. Initial analysis has shown that up to 50% of the robot programming time can be saved. What's more, that this procedure does not require extensive programming knowledge and thus, normal workers on site can program the robots.

System Base

The track-in procedure is based on the use of advanced infrared (IR) sensor technology in conjunction with industrial robots and consists of the following system modules:

- IR-sensor unit for detecting the position values and vectors directions. This sensor unit is available in three different sizes for different work areas. In addition, the sensor units can be coupled in order to achieve bigger working volume.
- Freely movable, hand-held programming tool with integrated PDA to calibrate the working environment and to detect the path points.
- Robot programming software will display the working area to simulate the robot path to optimize the process parameters. This can be applied to various robot models.
- Standard notebook with USB interface for sensor control unit and a serial port to robot controller.

Software

For other robot programs available on the market an open interface is provided through which the data transfer with the Track-in System can take place. Here, the robot coordinates and moving direction in their readable form are transferred to the robot and all the necessary calculations for the simulation and trajectory optimization can be performed. In addition, the whole working environments including geometric data of the components, fixtures, the robot and the tools can be simulated in the software. For example, the Mercator software provides a realistic simulation of the robot movements performed in a cell created from CAD data. The program can then be used to easily modify the robot path, as the path points can be moved, deleted or edited, new ones can be added. Each base point can also be continuously cre-

The robot's path can be teached by using the 6D programming handle whith integrated PDA

ated and adapted to the component contours. These changes can also be displayed graphically and in each case be reviewed by another simulation.

System Design

The infrared sensor system is installed so that the work space of the robot is completely covered by the sensors and the free moving 6D programming handle can be captured steadily along the robot path. Multiple sensors can be used in order to cover complex fixtures or work pieces. The 6D programming tool with integrated PDA is used to enter the path points, and to carry out the calibration of the working area. All the important functions for the task are available on the PDA, so the user does not need to interact with the monitor or PC. The sensor data is used in the robot software to perform the data for the robot path which is then directly transferred into the appropriate robot controller. The 6D programming tool can be charged in order to be able to work for 4 to 5 hours of operating time.

Measurement Applications

The connection between the IR sensor unit and industrial robots allows even for further improvements in addition to the online programming. This programming tool can be attached to the robot and can be used for automatic measurement works without depending on the robot system accuracy. The sensor unit records the measurement values and directly transfers them into a measurement program, such as PowerInspect, where further evaluations can take place. Simple online programming therefore offers the option of a flexible enforceable measuring robot for the efficient measurement of smaller product series.

Control and Security Applications

For example, if the robot joints are equipped with LEDs, their positions can be captured in real time and accurate motion control of the robot can be performed. This monitoring allows comparing these values with the values of two separate robot controls and thus raises through the resulting independent redundancy the safety in human-machine cooperation. In addition, the motion of working people in the robot's work cell can be monitored and can be exactly tracked. With a direct feedback of the detected positions and directions of the human movements the robot can be corrected to exclude a risk of collision.

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The Devil Is in the Details

3D Container Inspection System

In today's world of large organizations expecting a level of quality that at one time was deemed unnecessary; the differentiation for a vendor is sometimes the perceived level of quality. As the old adage goes, "The devil is in the details." Even if every part a vendor ships is of excellent quality, if the packaging of these parts is poor the perception of that vendor drops significantly. As a vendor the last thing you want is a negative perception just from packaging defects.

On the receiving side of this transaction, there are other concerns. If a box, bag, or other type of container has scratches, bangs, dents, or other physical defects, is the product inside going to be the quality you want either presented to your customers (in the case of a grocer) or processed on your manufacturing line (in the case of a manufacturer). When you receive goods you need to check to make sure that all of the packaging is as you expect as a first line of defense against bad product.

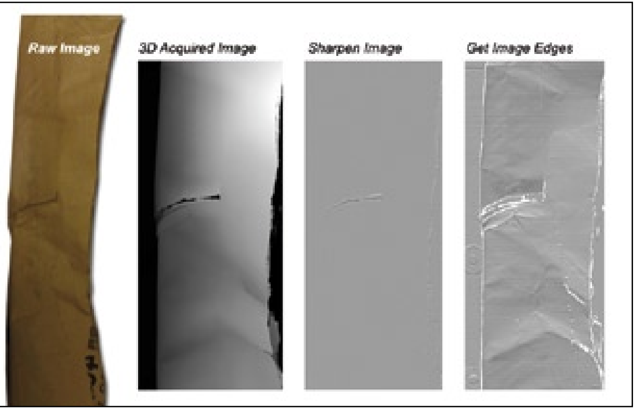
This problem is often dealt with in varying ways, but most often for both the vendor and the customer it involves an individual with a clip-board at the shipping or receiving dock doing a visual inspection. This inspection can vary greatly in effectiveness as well. This visual inspection method may be highly effective at 2:00 PM on a Wednesday, but for some reason the packages going through this check at 4:30 PM on a Friday or 8:00 AM on a Monday seem to have more defects go through un-noticed.

Costs of Bad Products

There are often unforeseen costs associated with packaging defects. From the vendor's point of view, imagine shipping a container of a food product to a grocer. The grocer notices a few broken boxes, a few torn bags, or some other product not sealed properly when they do a visual check of the shipment. It's not unheard of for this vendor to ship back a palette, or worse yet, an entire shipment because of this. This is the equivalent of a job application being rejected before the hiring company read the letter or reviewed the resume because you didn't seal the envelope properly. You may have been the best candidate for the job, but "the devil is in the details."

On the receiving side there are also costs associated with receiving bad product. For a grocer it's quite clear, you don't want improperly sealed product because it's product you can't sell. For a manufacturer or distribution center there are higher costs involved. Imagine some food product that isn't sealed properly coming completely open on your conveyors as they whiz through your facility. This product getting into gears and belts, not to mention all over the floor causes not only a mess for your janitorial staff, but could also stop your production lines or cause other maintenance issues.

Example of a defect that is quite difficult to detect and measure in a 2-D system, but is much more visible to a 3-D vision system



Machine Vision Solution

Cyth Systems was approached by several customers with these issues, and they turned to machine vision for a solution.

"Our customers have asked us to improve the quality of bagged food items, this may be a packet of chips or a sack of potatoes, the goal is always the same, ensure that both visually and operationally the bags are being sealed correctly," says Andy Long CEO at Cyth Systems.

On the surface, this may seem like a simple problem to solve, but with traditional 2D vision systems the challenges can be huge. Highly reflective irregular surfaces are almost impossible to process with 2D machine vision systems, and dents in cardboard boxes are almost invisible to a standard 2D camera. Paper style packaging seen in pet food bags have few defining textures for a typical camera to measure. Luckily 3D machine vision systems solve many of these issues.

While 3D measurements in machine vision are a vastly growing area and the technology in this field has come quite a long way in the last few years, it is still seen as something difficult to implement and isn't used in many areas where it should be. Cyth Systems has partnered with Sick and National Instruments to create a kit to simplify the process and lower the cost of implementing a 3D Vision System for packaging inspection.

3D Container Inspection

The Cyth 3D container inspection system has the following components:

Sick Ranger 3D camera – This camera is capable of acquiring over thirty thousand scanned profiles per second, creating high-resolution 3D images with better than 10 micron accuracy, even on a high-speed line.

National Instruments Vision Builder for automated inspection – Configurable machine vision software from a leading vendor of machine vision software.

National Instruments Embedded Vision System – A fanless industrial PC with industrial I/O, and a high-end Intel Core 2 Duo to support high-speed image processing.

Cyth also includes all of the cables, power supplies, lasers, and custom software steps required to make all of the above work together. The cost of the system also includes ten hours of pre-application support to ensure that when the user receives the kit it will already work for the first product, and ten hours of post-application support for issues that may arise after everything is installed.

These 3D systems can remove the numerous costs associated with shipping or receiving products with bad packaging, and ensure 100% inspection.

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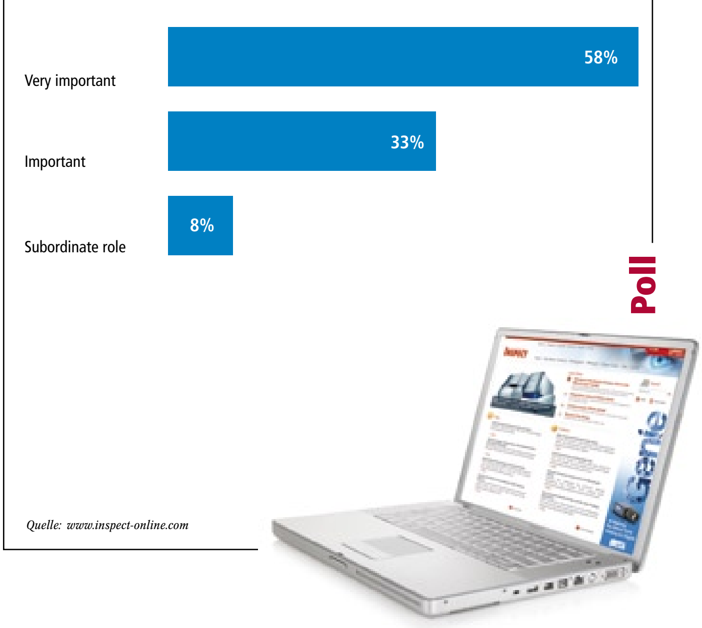
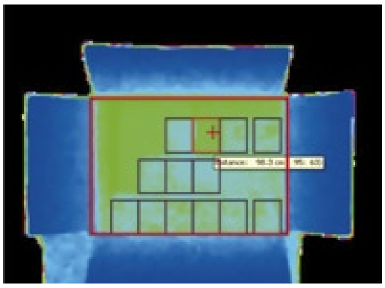
Illumination: How important is this for the solution of your machine vision task?



3D Package Inspection



Octum 3D package inspection systems detect reliably in 3D the position of any individual package or bundle based on 3D data supplied by TOF cameras. The inspection is performed based only on the geometrical description of the packaging and the expected horizontal and vertical arrangement of all packages in a layer, no other parameters are required. From a fixed camera position several packaging layers may be inspected without camera height adjustment. System calibration is also not necessary, it is performed automatically for any individual layer based on 3D data. The inspection may be performed with stationary or moving packages. With image acquisition times up to 50 images/s, cycle times of up to 600 inspections/min may be achieved.

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Enhancements to Omniview 360° Announced

Cognex announced its next generation OmniView 360° inspection system, now with color and 5 megapixel high resolution cameras. OmniView allows detailed inspection and verification of unoriented wine and juice bottles, canned goods, pharmaceutical vials and other cylindrical packages right on the production line. Using the latest Windows 7, 64-bit PCs, the system inspects products at up to 1,200 parts per minute without disrupting bottling and packaging lines. It uses four cameras positioned around the conveyor to capture views of all sides of a product. These are mapped into a 3D model using proprietary Cognex vision technology, and then inspected using Cognex's VisionPro software library. An additional fifth camera can be used to confirm that the lid or cap matches the label on the front of the package.

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TubeInspect Used in Finland

Uwira Oy, a Finland-based company, will now inspect their pipes with Aicons TubeInspect system. TubeInspect, which measures the tube with 16 high resolution digital cameras, calculates the tube's geometry within only a few seconds. The measurement results are reported in an easily understandable way, making it very clear if the pipe is within or outside of tolerance. At the push of a button, TubeInspect generates a user-independent and reproducible measurement report that can be forwarded to the customer.

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Inspected and Approved

IEF Werner introduced the profiLine positioning systems. These systems have the job of moving parts mounted on work-piece carriers to the required position for further processing. The IEF positioning unit with spindle drive was designed to combine the specific characteristics of a linear axis with those of a precision slide. These properties combine long strokes movements with high precision under the heavy stresses required in automotive production in particular. Its machined aluminium profile with profile rail guides results in a stiff guidance system with high load ratings and high running accuracy. The cover, comprising a profiled lid and a sealing lip system, provides a closed system without any stroke loss.

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Defect Detection on Painted Surfaces

With its innovative, robot-based inspection system reflectControl, Micro-Epsilon offers the possibility to recognize defects on painted surfaces. Furthermore, the system allows recording these defects. Afterwards they are marked on the vehicle. Compared to conventional visual audits, the system shows very high defect recognition rates while offering maximum reproducibility and availability. Producing 40–60 vehicles per hour, defects down to 0,3 mm in size can be detected during inspection. In order to ensure these reliable results, reflectControl is applied on four robots which are working in parallel in one line. All systems are equipped with a large monitor and four cameras. However, inspecting lasts less than 1s, each camera takes eight pictures per measurement position. Therefore, approximately 30 positions can be detected within 60 seconds in the case of usual robot speed.

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3D Surface Inspection In-line

With the frame grabbing and image processing technology developed by Edixia, it is possible to scan all surfaces of a product during the production run and to analyze the 3D images thanks to an image analysis program. Surface inspections as well as geometry measurements can be performed in real-time; results are available immediately in order to take corrective actions upstream. As with traditional 3D image analysis, a laser beam is projected onto the part and is captured by a camera positioned at a certain angle (based on the principle of laser triangulation). This enables a „contour line" to be produced. The system, known as 3D-Cast, consists of a laser beam projector, a system of sensors, patented optics to avoid shadow effects and an optical filter to avoid reflections.

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So Far, Yet so Close

Optical Profilometer Systems Inspect Hard-to-reach Surfaces

© Rodrigo Soldon/Flickr

NASA measures the thickness of liquid nitrogen in cryogenic chambers at its Propulsion Systems Lab. A standard full-field profilometer with a human operator could not fit into the chamber or work at these low temperatures. Instead, a fiber-based optical profilometer provides the solution: its fiber-based probe withstands the extreme environment and can be located hundreds of meters away from the interferometer. The signal quality stays constant over the distance.

White light interferometry has long been used in metrology fields to obtain micron-scale measurements and imaging of surface characteristics, cross-section imaging, and material thickness measurements. Still, a number of applications require particular versatility from their inspection system, beyond what is possible with a full-field profilometer. Certain applications call for measurements of long profiles (not possible with full-field), others need to measure translucent material thicknesses on moving surfaces like webs, others still require mapping of larger surfaces, without the need for tiling. Also, some surfaces are particularly difficult or impossible to inspect with full-field interferometers: the insides of small diameter tubes, the outsides of cylinders, as well as concave or convex spherical surfaces. Further complications are posed by surface inspections in environments involving radioactivity, extreme heat or cryogenic temperatures. To answer these challenges, the Canadian company Novacam has developed a fiber-based optical interferometer system and a wide selection of non-contact probes to suit laboratory or online installations. Fiber-based probes can be deployed far from the interferometer enclosure. They can be mounted onto a variety of positioning systems, facilitating integration into production lines and making many hard-to-reach surfaces accessible for imaging. The system offers the ability to scan long profiles and to map larger contiguous surfaces. Moreover, multiple probes can be connected to an interferometer with the help of an optical switch, thus lowering the cost per probe.

Principles of Optical Interferometry

A low coherence interferometer uses broadband light (1,300 nm wavelength). Light reflected from the sample creates interference patterns that determine the distance between the probe tip and the sample, with a precision better than 1 µm. Unlike full field interferometers or line sensors, which scan a small surface or a line at a time, a fiber-based probe acquires one point at a time and is typically displaced over the surface with a scanning mechanism.

What Kind of Surfaces?

Any surface, solid or liquid, can be scanned, mapped and characterized to sub-micron resolution. This includes surfaces with steep slopes and high-aspect ratio features like channels on fuel cell bipolar plates (fig. 1), grooves on CMP pads for polishing wafers, or cooling holes in aerospace blades. Such surfaces present a challenge to competing technologies. Triangulation sensors, for example, have trouble imaging high-aspect ratio surfaces. Neither triangulation nor color confocal systems can match the sensitivity or ruggedness of low coherence interferometry when it comes to high-aspect feature imaging. Because the Novacam profilometer emits and picks up light with a single probe, it is able to measure and image high-aspect ratio surfaces.

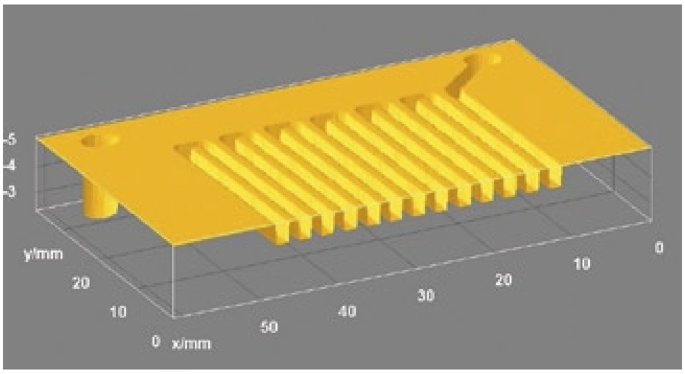

Fig. 1: 3D rendering of a fuel cell bipolar plate, an example of high-aspect ratio imaging

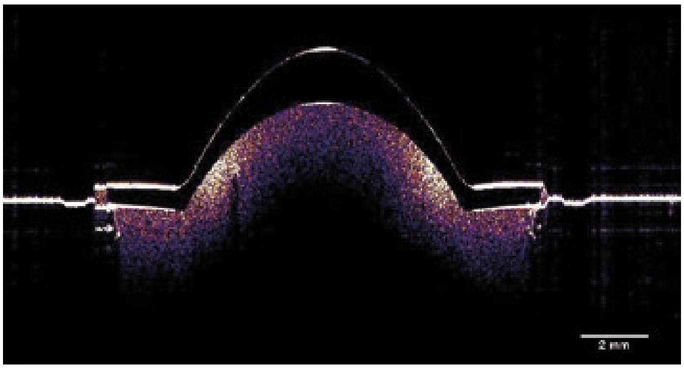

Fig. 2: Cross-section of an intraocular lens

Measurements Delivered

The probe scans the surface from a standoff distance of 1 to 150 mm, at a rate of 1 to 30 kHz depending on the model. Thousands of light interference measurements create a 3D image of the surface, facilitating defect detection. Given the point cloud data, application software calculates surface characteristic parameters, including surface roughness and waviness. For surface defects caused by wear or abrasion application software determines volume loss.

When used in cross-sectional mode, the interferometer obtains thickness measurements and cross-section imaging of translucent coatings or films whose optical thickness ranges from 10 µm to 8 mm. Materials differ in their translucence and light refraction characteristics, permitting the interferometer to detect reflections from the entry and exit of each material layer. Whether the scanned films are single layer or multilayer, thickness measurements are thus obtained simultaneously. Inspecting products such as an intraocular optical lens or a contact lens becomes intuitive: the interferometer provides a cross-sectional image (fig. 2) and calculates material thickness at any point desired. It can show volume density maps and 3D isosurfaces. The results can be analyzed for cracks, bubbles and other defects, and lens curvatures can be calculated.

Hard-to-reach Surfaces

Traditionally, hard-to-reach surfaces, such as interiors of aeronautics components, have been measured by taking a mold of the interior space and bringing this replica under a full field profilometer. In contrast, small-diameter fiber-based probes inspect surfaces inside tubes and other tight spaces directly. Probe diameters range from 0.9 to 5 mm. The probes are mounted on either a combination of two or three linear or rotational axes, or on a CNC machine or a coordinate measuring machine. For example, a scanning arm inserts a side-facing probe between closely spaced blades of an aerospace engine blisk (fig. 3). Leading edges of turbine blades can be accessed and inspected similarly. A scanning probe can inspect the interior of a diesel fuel injector, or the cylindrical cavity of an engine block, or of a gun barrel. Inspecting smaller tubes, with diameters as small as 2–10 mm, is made possible with flexible two meter long side-looking (90°) rotational probes with pullback.

Probes in Action – in Process or Lab

Since fiber-based probes can be located hundreds of meters away from the interferometer enclosure without signal degradation, a variety of operating environments become possible. For one, probes are readily placed for in-line measurement. When mounted onto linear scanning stages, they are able to scan across fast-moving production webs, delivering long profile or thickness measurements in real time. Multiplexing of probes which are connected to one interferometer offers additional potential value.

2D Galvo probes (with light-deflecting mirrors attached on a galvanometer) are effective for scanning smaller surfaces (less than 15 x 15 mm) or volumes. Combined with a linear stage, a band of up to 1.5 cm wide can be acquired. These are ideal for applications such as inspecting electronic packaging and MEMS or optical lenses.

The rugged probes are also able to operate in hostile environments, including radioactive chambers, very hot environments (in proximity to molten metal) and cryogenic environments. Thus, even the simulation of outer space condition at NASA is made possible.

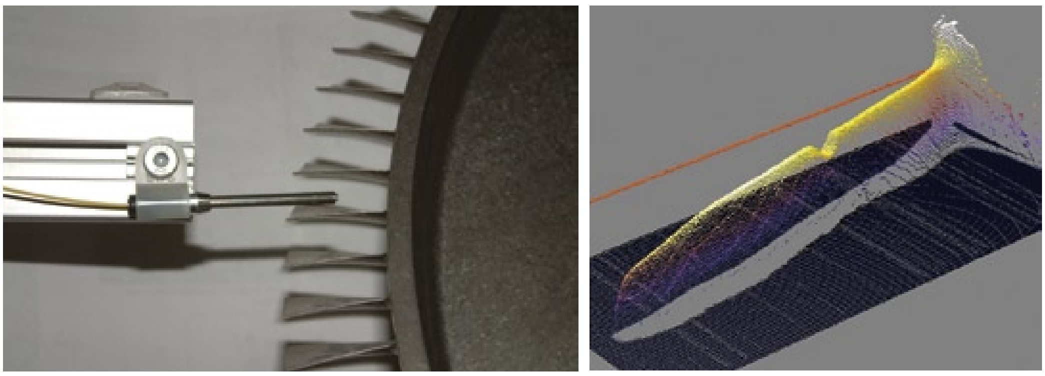
Fig. 3: A fiber-based probe mounted on a scanning mechanism inspects the surface of blisks (bladed disks used in aeronautics). A leading edge of a turbine blade can be accessed and inspected.

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Gouges and Grooves

Inspecting Surface Defects through Roughness Parameters

Coatings decrease frictions. Its use saves energy and at the same time preserves the product. To ensure the surface quality directly in the production process white-light sensors based on the principle of chromatic aberration are well suited. They detect defects using roughness measurement.

Ever increasing importance falls onto the texture and other physical properties of technical surfaces. New materials, coatings and manufacturing technologies are being developed with the goal to take advantage of specific surface properties and to optimize the production pro-cesses. Through optimized surface properties, the weight of a component can be reduced or the friction of a surface can be minimized. Resources will be spared; material cost and production time will be reduced. In order to recognize and eliminate process excursions in time it is useful to measure surface parameters which are important for quality directly in the production process. Because of short cycle times in production and the often complex geometries of the samples, non-contact metrology solutions offer distinct advantages.

The CT R200 is designed to detect surface defects on round and rotationally symmetric parts. The heart of the system is a chromatic white light sensor that takes advantage of chromatic aberration. A very bright white light source focuses a small spot onto the sample surface with the different wavelengths focusing on slightly different focal planes. The reflected light is collected and a spectrometer analyzes the light intensity versus its wavelength. A height reading is generated from the maximum intensity of a certain wavelength on the spectrometer. The sensor achieves a resolution of 0.01 µm.

Inside and Outer Diameters

A high precision theta stage is rotating the sample while the stationary sensor scans the surface in a user-defined step size. The system takes measurements with a data rate of 14 kHz and the data acquisition is synchronized with the high resolution angle encoder of the rotary stage. A scan of a 10 cm diameter sample with a resolution of 5 µm takes 7 seconds. The minimal lateral step size is 1 µm. To measure even smaller diameters, cyberTechnologies uses folded optics. The smallest inside diameter that can be measured with the CT R200 is 35 mm.

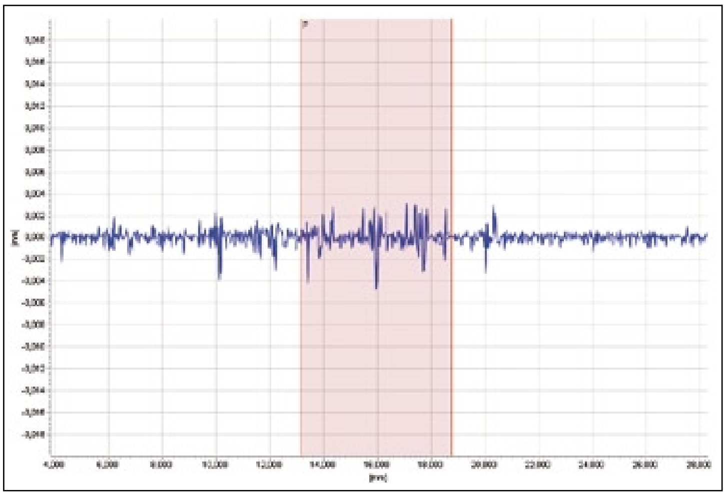
The size of the outer diameter depends on the linear range of the x-axis.

The device CT R200 with white-light sensor on top of a massive granite platform

The surface of a round part is inspected for defects

With the standard CT R200 parts with an outside diameter of up to 200 mm can be measured.

Using an automated x- and z-axis, different diameters on the same part can be scanned. Depending on the step size and the required cycle time, any number of tracks can be measured. The system can be used to identify grooves, measure sur-



Roughness analysis of a part

face texture and centricity as well. Depending on the surface texture, grooves on the order of microns can be identified reliably.

All the standard roughness parameters like Ra, Rmax and Rz can be measured with repeatable accuracy. An automated probe tip simulation allows the user to generate roughness measurement results comparable to tactile measurements in order to support the maintenance of manufacturing baselines. The exact diameter, as well as the roundness of the component will be measured.

Sustaining Focus of the Sensor

The particular sensor has a dynamic measurement range of 300 µm. To measure samples with roundness or a concentricity of more than 300 µm, the CT R200 is mounted on a closed loop controlled x-axis that effectively extends the sensor's dynamic range as needed for the application. The autofocus routine positions the sensor at the optimal distance of the surface. During the scanning process the x-axis adjusts the distance to the part automatically in real time. The height reading is a combination of the calibrated x-axis signal and the sensor height readout. The linear measurement system is separate from the drive and is positioned in one axis with the white light sensor. This eliminates any angular errors. The accuracy of the x-axis is in the same range as the accuracy of the sensor, hence there is no degradation of performance due to the motion of the x-axis.

The big advantage of this implementation: The fixture tolerances have no effect on the measurements and elaborate efforts to center or chuck the sample are not necessary.

The automated and dynamic focus system ensures a high degree of safety. In addition, the sensor head is integrated via an anti-collision device. In case of any contact with the measurement object, the sensor will disengage and all axes will stop. Thus damage of the sensor or the sample is avoided.

Solid and Reliable Design

The system´s motion system is built on top of a massive granite platform. To dampen any environmental vibrations, the base frame is mounted on vibration isolation elements. In a typical use case on the production floor, a multi-axis robot will load the parts onto the system and remove them after the measurements are completed. Parts that fail to meet the process control criteria are automatically sorted out. The operating software provides the respective interfaces to integrate the CT R200 into the production process. All data analysis is handled by the cyberTechnologies Scan Suite metrology software package. The roughness results are measured according to published norms and are provided with respective tolerances. Bad parts can be marked. If the measurement is not correct (no go) the user has the option to review the individual scan profile and to further evaluate the defect. All measurement results will be saved and archived with a traceable data matrix code.

With its high resolution and high measurement speed, the non-contact CT R200 inspects surface defects and automatically measures technical surface parameters like roughness directly in the production process on round and rotationally symmetrical parts.

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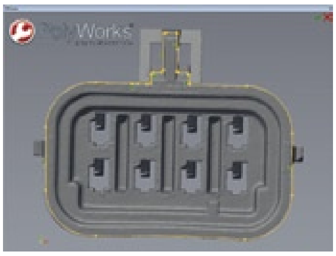
Parametric 2D Sketching for Solid Modeling Workflows



InnovMetric Software and its European distributor Duwe-3d are pleased to announce that the version 12 of PolyWorks/Modeler will offer new parametric 2D sketching capabilities. This development project is inscribed within a vision of true interoperability with CAD/CAM applications in which the role of PolyWorks is to optimize geometric entity creation on digitized polygonal models and accelerate the production of 100% native models in professional CAD software. Plug-ins for SolidWorks and Autodesk Inventor CAD software are initially planned and will allow the import of sketch entities and constraints.

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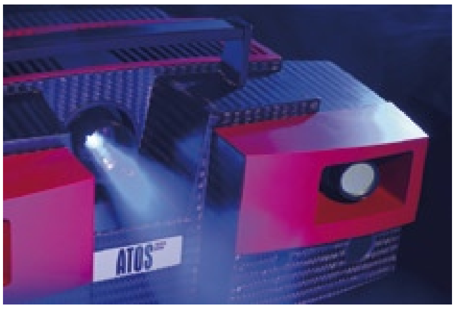
New Mobile 3D Scanner



The new generation of mobile 3D digitizers from GOM is a totally new development based on unique technology. Atos Triple Scan uses all the viewing angles of the stereo camera system (three-in-one sensor). It is also based for the very first time on a completely new projection technology. The scanner therefore enables easier, faster and more reliable measurement processes and greatly reduces the number of single scans. Triple Scan is equipped with blue light technology, which features extremely long LED service life, minimum heat development and low maintenance. The narrowband blue light enables precise measurements to be carried out independently of environmental lighting conditions.

GOM - Gesellschaft für Optische Messtechnik mbH · Tel.: +49 531 39029 0 · info@gom.com · www.gom.com

Opto Launches Troublebox

TroubleBox by Opto has been designed using the latest, affordable high speed technology based around mainstream Gigabit Ethernet computing technology. This highly competitive system comprises a high speed camera, LED micro-flood light, flexible mountings, and a unique high speed capture software suite enabling it to run from a simple laptop. The Troublebox system enables users to capture and analyze the fastest, smallest events of a manufacturing process, frame by frame, automatically, anywhere in a production line. Videos and stills can be exported to common formats to share and discuss.

Opto Sonderbedarf GmbH
Tel.: +49 89 898 055 0 · info@opto.de · www.opto.de

Geomagic Announces Update to Version 12 SR1

Geomagic has announced that its 3D reverse engineering and inspection software products have been updated to enable new features and support additional languages. With the release of Version 12, Service Release 1, Geomagic Studio, Geomagic Qualify and Geomagic Wrap have been updated to support users who speak Portuguese, Czech and Russian. This is in addition to the wide range of languages previously supported (English, German, French, Italian, Chinese, Japanese and Spanish) by Geomagic software. Version 12 SR1 also includes advanced support of 3D mouse functions for improved 3D navigation and support for import of Vialux scan data.

Geomagic, Inc. · Tel.: +1 919 474 0122 · inquiry@geomagic.com · www.geomagic.com

Six Cameras See More

With the ProfilControl 6 series, Pixargus is presenting a new generation for surface inspection of profiles. The expanded range of functionalities offers new possibilities in quality control and makes operation and maintenance much easier. Pixargus has thoroughly redesigned the series of its ProfilControl suite of surface inspection systems. It now features numerous new functions which facilitate both set-up and operation of the system. In addition to optimizing the lighting and camera equipment, the Pixargus engineers redesigned the system with the objective in mind to minimize the manual set-up effort and in doing so eliminate a major source of error. The standard version of the system comes with six high-performance line scan cameras arranged around the profile at angles of 60°.

Pixargus GmbH · Tel.: +49 2405 47908 0 · info@pixargus.de · www.pixargus.de

Slashing Inspection Time

Nikon Metrology introduces the Laser Radar MV330/350 for automated large-scale metrology applications. The new Laser Radar doubles measurement speed and performance, offers better data quality through improved signal-to-noise ratio, and features enhanced hole and edge measurement to cover more applications. Its proprietary laser reflection technology obsoletes tedious positioning of targets at difficult-to-access locations, as is required with laser tracker or photogrammetry systems. Through manual and automated non-contact measurement, Laser Radar is a productivity multiplier, supporting metrology-assisted production in aerospace, alternative energy, antennae, satellites, oversized castings and other large-scale applications.

Nikon Metrology NV · Tel.: +32 16 740 100
info@nikonmetrology.com · www.nikonmetrology.com

3D Data Acquisition with SmartScan 3D

Breuckmann will for the first time present their extended smartScan 3D product series. Thanks to Interface FireWire(B), this modular system for the precise three-dimensional data acquisition of objects now delivers even quicker and more reliable performance. Flexibility is an additional key feature: the smartScan 3D product series grows with client projects. Thanks to its consistent hardware platform, the system modules are easily extendable and adjustable in line with increasing project requirements. In order to deliver accuracy and high standard data quality, for example in connection with industrial measurements, the system is equipped with low-noise CCD cameras (a broad range from 1.4 to 16 MPixel) and quality lenses.

Breuckmann GmbH
Tel.: +49 7532 4346 0 · info@breuckmann.com · www.breuckmann.com

Contact-free Thickness Measurement

LAP Laser presents a new system for measuring the thickness of strip products. The new Calix not only measures shiny metals for example, it can also measure the thickness of matt black rubber calender strips. The Calix system detects the thickness of the continuously running strip inline to a +/- 1 µm degree of precision. The measured values are displayed numerically and graphically and the system provides feedback as soon as the tolerances are exceeded. LAP uses an optical measuring process which works independently of the material being measured: this means that the characteristics of the material do not need to be modified to suit the measuring system – as is the case for example with radiometric thickness measurement.

LAP GmbH Laser Applikationen
Tel.: +49 4131 9511 95 · info@lap-laser.com · www.lap-laser.com

Small and Light 3D Laser Scanner

Faro Technologies introduces the new Faro Laser Scanner Focus3D, a high-performance 3D laser scanner for detailed measurement and documentation with intuitive touch screen control. With its dimensions of 24 x 20 x 10 cm and a weight of 5 kg, the Focus3D is so compact and mobile that users can always take it with them, wherever they go. The Focus3D is suitable for documentation of large environments, quality control of components and reverse engineering. Thanks to its millimeter-accuracy and its 976,000 measurement points/second, the Focus3D offers the most efficient and precise method for measurement and 3D documentation of building construction, excavation volumes, façade and structural deformations, crime scenes, accident sites, product geometry, factories, process plants and more.

Faro Europe GmbH & Co. KG · Tel.: +49 7150 9797 0
info@faroeurope.com · www.faro.com

Visionaries

Interview with Terry Arden, CEO LMI Technologies

INSPECT: Market studies of the industry associations from both sides of the Atlantic point this out: Optical 3D technologies are clearly on the rise. For LMI, global manufacturer of 3D Sensor Technology for more than 30 years now, this is nothing new, right?

T. Arden: Indeed – this is nothing new. With 3D measurement as our business focus we continually see the interest increase. Significant is that LMI remained profitable in 2008 when the overall industry for machine vision felt the downturn which I believe reflects the interest in this technology and its benefits.

What have been, from your point of view, the main technological breakthroughs leading to a much higher interest in 3D machine vision and inline 3D metrology on the customer side today?

T. Arden: Looking at the technology - it is primarily driven by the success of the CMOS imager where sensitivity, noise level, and frame rate improvements have delivered high performance yet low cost 3D solutions. This is also supported by a healthy selection of faster embedded processors and the standardization toward Ethernet. All of this has provided a backbone of technology that drives solutions with higher accuracy and higher speeds to solve 3D vision problems.

I also believe that the 2D world has come to a level of maturity such that future advances in algorithm development may come in smaller incremental improvements. Attempts to use 2D cameras and algorithms for 3D applications can become very complex and may be less robust than what can be a simple 3D solution. Whenever there is an attempt to solve a problem with complex algorithms to translate data from one realm (2D) into another (3D), the results may not be as robust or predictable. In other words, 2D provides many, many great solutions for the flat domain it was intended but 3D provides many, many better solutions for the real world.

I believe that the vision industry is realizing that 3D is the right solution for many inspection problems that 2D can't effectively solve – specifically where edges cannot be generated by simple illumination from which measurements are driven. 3D provides another dimension from which to create edges and therefore measurement features where 2D fails.

What will be the main application areas for 3D machine vision in the future?

T. Arden: Measurement, inspection, and error proofing for factory automation. Measurement to determine how to process the raw material based on size or shape at the input to a process or to provide a quality check to determine size or shape at the output of a process. Measurement requires cross-sectional tools to calculate values such as width, height, angle, area or compare to golden profiles.

Inspection for examining part surfaces to identify flaws. Smart 3D sensors such as Gocator (our latest innovation), self-trigger to scan whole parts (built from a series of cross-section profiles), then orient scans to a golden template and perform part surface comparisons to identify manufacturing flaws.

Error proofing to monitor tool wear and position involved in part manufacturing. Tools that pierce, drill, insert, or remove material degrade over time. With 3D monitoring of tool tip position or shape, maintenance can intervene to prevent part non-conformance.

LMI, being OEM supplier of customized solution for many many years could be considered a true "hidden champion". Recently, however, with the Gocator product line you also started offering end customer products. Is this a paradigm change for the company?

T. Arden: This is a good question. Thank you for recognizing our years of experience and position in the market place for 3D technology.

The Gocator is not a paradigm shift. It is taking all of our product and application experience and applying it towards factory automation – an end user market that demands simplicity for success. The main shift, if you want to call it that, is to make this an accessible and versatile 3D sensor for all users from the factory floor technician through to the system integrators and equipment manufacturers.

What the Gocator specifically targets is to create a great user experience. All too often, companies think their mission is to deliver technology and they often guess at customer pains and needs. What people really want, I believe, is to purchase a result or experience that technology helps us deliver based on identifying typical use cases and value positioning. For Gocator, the web browser is a technology that helps us deliver 3D measurement appropriate to factory automation end users. With a Gocator, the user experiences an attractive and responsive graphic interface that enables easy set up and operation – the value positioning. In all situations the users sees what the sensor sees with real-time, highly visual feedback. A user can select any number of measurement tools, select pass/fail decisions, or output over analog, digital I/O, or TCP/IP to a host computer – the typical use cases. A 1st time user can set up and have the sensor fully operating in a very short time – within an hour – with no previous 3D experience.

Terry, you have been an entrepreneur yourself, you have founded a company in the early 90s which you later sold to Dalsa Coreco. Today you are leading a successful company in a similar technology field. What would be your recommendation to the innovative newcomers: found your own company, or join a player already successful in the market and bring your ideas for great products into fruition there?

T. Arden: That's another good question and thank-you for recognizing my past achievements. My advice would be to pursue your passion, become a leader, and build value by changing the world in a way that makes sense for your temperament – either by means of a start-up (which is certainly not for the light-hearted) or by joining a seasoned company looking for bright, energetic people who bring commitment and vision [no pun intended].

Thank you very much for this interesting discussion.

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Preview

Our next issue will be the annual INSPECT Buyers Guide:

The INSPECT Buyers Guide is the official Buyers Guide of the European Machine Vision Association (EMVA). It is the first ever published European reference for components, products, systems and services for machine vision and optical metrology. The Buyers Guide will be enriched with overview maps, articles covering machine vision trend topics, and product show cases.

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