Made to measure

Measurement is a main-stay for automated inspection and has provided the platform for ever faster, more efficient and more accurate quality control. In addition to preventing defective product reaching the customer, vision measurements can also be directly linked into statistical process control methods to improve product quality, reduce wastage, improve productivity and streamline the process.

Machine vision does not examine the object itself - measurements are made on the image of the object on the sensor. All of the factors that contribute to the quality of that image must be optimised, so careful consideration must be given to every element of the machine vision system, including lenses, illumination, camera type and resolution, image acquisition, measurement algorithms, as well as external factors such as vibrations, electromagnetic interference and heat.

Measurements fall into 3 categories: 1D, 2D and 3D. 1D measurements are typically used to obtain the positions, distances, or angles of edges that are measured along a line or an arc. 2D measurements provide length and width information and are used for a host of measurements including area, shape, perimeter, centre of gravity, the quality of surface appearance, edge based measurements and the presence and location of features.

Pattern matching of an object against a template is also an important part of the 2D armoury. Reading and checking of characters and text, and decoding 1D or 2D codes is another key activity. The emergence of many affordable 3D measurement methods provide length, width and height information, allowing the measurement of volume, shape, and surface quality such as indentations, scratches and dents as well as 3D shape matching.

Good accuracy and repeatability of vision-based measurements are of paramount importance. Accuracy is an indication of how close the actual measurement is to the true value. Repeatability shows the closeness of a number of repeated measurements. A group of measurements could have poor accuracy and repeatability, or good repeatability but poor accuracy, or good accuracy but poor repeatability, as well as the desired combination of good accuracy and repeatability.

We’ll take a look in more detail at some machine vision measurements and the factors that affect them in the centre pages. Thanks are due to UKIVA members Bytronic Automation, Clearview Imaging, Multipix Imaging and Stemmer Imaging for their contributions to these features.
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Measurement was one of the first applications of machine vision. With the correct setup of lighting and lens you can get a good high contrast image and calibrate the pixels to real world co-ordinates. The system will then run for any length of production cycle, giving consistent, calibrated results. This releases the operator to work more efficiently, thus increasing productivity and creating jobs. But over recent years the cost of an entry level camera has decreased and higher resolution and higher speed systems, especially with the new CMOS sensors, have become more affordable, opening up even more applications. Also improvements in LED lighting have reduced the power consumption and heat produced during inspection, reducing the overall system power costs.

I’d like to take this opportunity, on behalf of UKIVA members, to welcome Dr Andrew Mint as the new CEO of the PPMA Group. Andrew brings extensive experience in production innovation, market development and international development to the role. He has established a successful career in the process industries developing cosmetics for major blue-chip companies as well as managing many significant large global businesses, helping to launch new products and novel technologies into the marketplace. He also has significant FMCG experience having undertaken various technical roles at Procter & Gamble amongst others. We wish him every success in his new role.

Finally, I’d like to encourage readers to consider submitting an entry for the ‘Most Innovative Machine Vision Project’ – one of the PPMA Group Industry Awards. This award is judged by a fully independent panel of industry specialists and is not restricted to UKIVA members. It is open to all vision equipment suppliers, system integrators or end users that have installed an innovative vision system, with recognition for all parties involved in the project. In 2015, the award was won by Multipix Imaging and systems integrator, MVT Ltd, with a measurement system for pharmaceutical tablet tracking and inspection – more details elsewhere in this issue. Details on how to enter will be published on the PPMA Total show website, www.ppmatotalshow.co.uk/awards

Ian Alderton, UKIVA Chairman
High speed text reading and verification on cans

A recent project for Acrovision required the reading and verification of 2 lines (14 characters) of text on the base of a drinks can at speeds of up to 1000 cans per minute. In addition to the challenge of reading and decoding ink-jet characters at such a speed, provision needed to be made for character size variation due to resetting of the ink-jet head after cleaning, as well as having to ignore embossed characters underneath the print. Acrovision used image filters and other OCR tools to enhance the edges of the character patterns to enable accurate and reliable reading. Close customer liaison was required to integrate the vision system into their PLC control, resulting in a robust and successful solution.

Entry-level Mako camera family extended with Sony’s IMX249 sensor

A new model is now available within the ultra-compact, low priced Mako camera family. Allied Vision’s new Mako G-234 broadens the range of products equipped with Sony PregiusTM CMOS sensor technology. With its high sensitivity and an outstanding image quality the Mako G-234 is an ideal candidate for the transition from CCD to CMOS technology.

The camera enables high-quality imaging with frame rates up to 40 fps at full resolution (1936 x 1216 pixels) and offers the same impressive image quality as higher-speed cameras equipped with an IMX174 sensor (e.g. Manta G-235), but for a much lower price. High saturation capacity and low noise figures result in an outstanding dynamic range of more than 73dB making the camera ideally suited for applications with large variations of light within the same scene.
New Sentech cameras with Sony Pregius 5.1MP and 3.2MP GS-CMOS sensors.

Sentech have added new models featuring the Sony Pregius™ family of global shutter CMOS sensors to their range of USB3 Vision cameras. These sensors are known for their excellent picture quality, high dynamic range and fast frame rates. The STC-MXS510U3V colour and monochrome cameras use the 1.2in format 5.1MP IMX250 sensor, running at 75.5 fps (8-bit) at the full 2448 x 2048 pixel resolution. The STC-MXS322U3V colour and monochrome cameras use the 1/1.8in format 3.2MP IMX252 sensor, running at 121fps (8-bit) at the full 2048 x 1536 pixel resolution.

All models also feature 10-bit and 12-bit output, as well as up to 64 Pixel Defect Correction. Specifications include ROI, advance trigger options and binning (monochrome cameras only). Software and SDK are included.

BAUER

LX VisualApplets cameras for easy intelligent image pre-processing

The new LX VisualApplets cameras from Baumer carry out image pre-processing directly in the camera’s FPGA. This reduces the volume of data to be transmitted and processed by the PC-based image processing system bringing enhanced application performance or reduced system cost.

FPGA programming is performed using Silicon Software’s VisualApplets, graphical development environment. Applets for many standard image pre-processing tasks such as image optimisation, data reduction or process control allow high resolution, high...
Within the Food, Drink and Pharmaceutical industries, retailers are becoming more and more stringent about their suppliers meeting correct packaging specification criteria. The result of incorrect labelling can result in poor customer satisfaction at best – at worst, hefty fines or Emergency Product Withdrawals (EPW).

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speed image data to be processed efficiently, cost-effectively and in real-time. Even complex algorithms for demanding inspection tasks can be quickly and easily implemented to application-specific requirements by end users without in-depth FPGA programming knowledge. The new LX VisualApplets cameras integrate Global Shutter CMOS sensors by CMOSIS and a GigE Vision compliant interface. The cameras are available with 4, 12 or 20 megapixel resolution with up to 74 fps.

**CLEARVIEW IMAGING** www.clearviewimaging.co.uk

**VST telecentric lenses for high resolution sensors**

VST developed the VS-TCT range of telecentric lenses (www.vst.co.jp/en/products/machinevision/lenses/10-mega-pixels-high-resolution-telecentric-lenses/) specifically for making precision measurements when coupled with the latest high resolution sensors. This is because telecentric lenses that were optimised for large (7-14um) pixel cameras fail to perform well with high resolution sensors.

The VS-TCT range is optimised for pixel sizes as small as 1.67um over a 2/3” sensor, equivalent to around 10MP. With a wide maximum aperture and high NA they ensure the best image possible when coupled with high resolution cameras such as Point Grey’s 9MP Grasshopper3 (GS3-U3-91S6M-C).

**COGNEX** www.cognex.com

**Cognex introduces new vision sensor powered by In-Sight**

Cognex has introduced the In-Sight® 2000 series, combining the power of the In-Sight vision systems with the simplicity and affordability of a vision sensor. This out of the box solution is ideal for solving simple error-proofing applications, offering ease of use and flexibility thanks to the powerful combination of proven In-Sight vision tools, a simple setup, and a modular design with interchangeable lighting and optics.

The integrated, high-performance image formation system consists of field interchangeable lenses and a patent-pending LED ring light that produces even, diffuse illumination across the entire image, eliminating the need for costly external lighting. The lens and colour of the integrated light can be selected to suit the application. The In-Sight Explorer™ EasyBuilder® interface allows even novice users to achieve extremely reliable inspection performance in nearly any production environment.

**IDS IMAGING DEVELOPMENT SYSTEMS GMBH** www.ids-imaging.com

**Versatile USB3 Imaging Options**

A number of new colour and monochrome sensor options have been added to the 2nd generation of USB 3 uEye CP CMOS cameras. The UI-3130CP, UI-3160CP and UI-3180CP feature high-speed ON Semiconductor PYTHON 0.5, 2.3 and 5.3 megapixel sensors respectively while the UI-3080CP and UI-3280CP cameras utilise Sony’s 5 megapixel Pregius™ IMX250 and IMX264 sensors.

The USB 3 uEye CP cameras make full use of the high frame rates offered by the ON Semiconductor PYTHON series of sensors. The special AOI feature of the sensor allows more than 1000 fps to be achieved on smaller regions of the image. The UI-3160CP provides full HD at more than 180 fps while the UI-3180CP offers the highest resolution class in the market and its large optical pixel area is ideal for applications in the field of microscopy.

The 5 megapixel UI-3080CP and UI-3280CP cameras benefit from the exceptional image quality and high dynamic range provided by the Sony IMX250 and IMX264 sensors for applications requiring low-light sensitivity as well as microscopy.
Vision systems for collaborative robots aid productivity

IVS is providing vision systems for the UR3, UR5, and UR10 collaborative robots from Denmark’s Universal Robots to enhance productivity. IVS, whose vision systems can be integrated with all major robot manufacturers and control systems, utilises the robots for the inspection of complex components as well as providing positioning feedback to the robot.

These affordable lightweight robots are designed to work side by side with human workers, increasing labour and total factor productivity and eliminating the need for costly precision fixtures allowing different parts to be processed and inspected without changing tools. The UR3 is a smaller table-top robot that can be used to provide camera inspection on multiple sides of complex parts and components, allowing precision automated inspection.

By using the robots for inspection processes, human workers can be redeployed to higher value tasks that robots cannot do. In the future inspection benches will include space for an operator and a robot to work in partnership as part of the quality control process.

Assembly Inspection Video Using Matrix Design Assistant 4

Matrox Imaging have produced a video (www.matrox.com/imaging/en/products/software/design-assistant-machine-vision-software/videos/#assembly_inspection) to show how Design Assistant 4 enables rapid development of vision applications using its intuitive flowchart-based hardware-independent integrated development environment.

The video highlights how product inspection can be automated by identifying features, taking measurements quickly and reliably and checking for defects with great accuracy.

Matrox Design Assistant 4 enables users to interactively design a web-based graphical operator interface for the application and supports direct interaction with essential automation equipment. It can cost-effectively handle typical multi-camera inspection applications in the packaging, food, beverage, healthcare, personal care or pharmaceutical industries.

CV3770 combination checkweighing and optical inspection

Mettler Toledo’s CV3770 (www.mt.com/uk-cv3770) is an advanced inspection solution which combines both checkweighing and vision inspection in a single process, helping to prevent both label mix-up and ensure weight verification.

The CV3770 is the first product inspection solution designed for continually detecting defective products, ensuring accurate weights, correct labelling and verification of critical prints. The system also complies with BRC and IFS quality standards criteria, helping to maximise product safety.

By immediately detecting label mix-up or irregularities including expiry dates or lot and batch numbers, manufacturers can minimise costly product recalls and increase productivity by reducing re-work. In addition, the checkweighing function accurately verifies product weight and reliably rejects over and under filled products. This helps reduce product wastage and maintain local weights and measure legislation.
For the highest industrial digital image quality, camera features and functions must interact in perfect harmony. Whilst many industrial cameras include a standard set of image pre-processing features, camera manufacturer Basler have gone even further with the innovative in-camera PGI image optimisation technology.

The powerful PGI technology is based on a combination of 5x5 debayering, colour anti-aliasing and sharpness improvement which all contribute to improvements in the debayering calculations used to produce the colour image from an image sensor overlaid by a Bayer matrix. PGI also includes de-noising functionality which reduces image noise by avoiding the effects of colour noise and also providing additional active noise filtering.

These individual PGI processes eliminate colour errors, ensuring colour fidelity even in the finest image details, as well as excellent sharpness and reduced image noise. In-camera PGI optimisation reduces the workload on the interface PC which ensures maximum processing resource for other tasks.

Available on the latest Basler camera models, this new technology is applicable for all colour inspection applications, from industrial surface inspection to dermatology and microscopy.

The PL-D725 cameras from PixeLINK combine the benefits of high frame rate and global shutter CMOS technology with the high speed data throughput of USB 3.0. These colour and monochrome cameras provide low noise images for outstanding value in a broad range of industrial applications, such as medical, high performance security and surveillance, parts inspection, metrology and biometrics, welding inspection, PCB and flat panel display inspection. The cameras are based on an ON Semiconductor 5.3 megapixel (2592 x 2048) resolution sensor capable of 75 fps at full resolution. A flexible region of interest function allows operation at even higher frame rates on a user-selectable area of the image.

The extensive built-in image pre-processing capabilities give outstanding image quality, less load on the system and higher performance. These cameras provide a choice of 8-bit or 10-bit digitisation and a dynamic range of 53dB in 10-bit mode. The external hardware trigger and 2 general-purpose outputs ensure users have the flexibility to synchronise the camera with their processes and illumination.
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SICK TriSpector 1000 delivers real plug-and-play 3D vision sensing

Sick’s new TriSpector 1000 ‘plug-and-play’ 3D vision sensor delivers real-time 3D quality inspection in a self-contained unit that is simple to install and use. It will provide FMCG product pick, placement and packaging operations, contract packers and warehouse operators with true ‘out-of-the-box’ 3D vision without the complexity or cost of conventional 3D vision solutions.

The TriSpector 1000 can be set up using SICK’s SOPAS software interface. Its intelligent sensing can check presence, position, labels, contents and orientation, dimensioning and height, which-side-up and fill levels. It will achieve true 3D vision, even when colour, position and height of the object vary, and can tolerate changes in angle or position of packages on the conveying line. The TriSpector can integrate with factory control and data systems through SICK’s 4DPro communications platform, and combine with other 2D or 3D vision devices to create a full inspection station for QC purposes. There are three models in the range offering a choice of width and height ranges and different fields of view and resolution to match application requirements.
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Stemmer Imaging can now offer the Boa Spot vision sensors from Teledyne DALSA

Designed for automating basic inspection tasks on production line, such as detecting the presence or absence of features and performing simple measurements, the self-contained Boa Spot provides vision system performance at vision sensor pricing.

Available with 640 x 480 or 1280 x 960 image resolution, Boa Spot can inspect multiple part features at the same time, and at higher speeds and with greater accuracy than traditional photoelectric sensors. Embedded vision tools are provided for part locating, feature finding, counting and measuring applications and can be used in any combination.

Boa Spot vision sensors offer integrated LED lighting with multiple available colours, lens cover, and easy-to-use software to deliver high value capabilities at a low cost of ownership which allows more points of inspection on manufacturing and packaging lines. This gives better failure analysis and allows corrective action to be taken more quickly and easily, thus improving quality, reducing scrap, and increasing throughput.

Versatile I/O for control and interfacing are provided. Standard factory protocols, such as Ethernet/IP and Profinet, are directly supported for communicating with 3rd party equipment or other factory devices. Boa Spot can be run on the same network as other vision systems in the Boa range. Inspections can be triggered by parts in motion or from a PLC after being moved into a stationary position.

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Allied Vision supplies camera technology and image capture solutions for industrial inspection, science, medical, traffic monitoring and many more application areas in digital imaging.
Alrad Imaging is a prime UK distributor of vision products. Products include cameras and sensors, frame grabbers, illumination, imaging software and sub system solutions for OEMs and system integrators.
Baumer is one of the leading global manufacturers of innovative image processing components and offers an extensive product range of high quality industrial cameras and vision sensors.
ClearView Imaging is a supplier of vision components, including a wide range of cameras, frame grabbers, software, embedded systems, smart cameras, vision processors, lighting and optics.
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Leuze electronic 'the sensor people' are the experts for sensors. They also specialise in smart cameras and identification products.
Matrox Imaging is a leading developer of hardware & software for machine vision and imaging technology.
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National Instruments manufactures hundreds of integrated software and hardware products, which are used to replace and/or communicate with traditional instrumentation.
Omron Electronics manufactures a wide range of vision-based industrial solutions, ranging from cost effective vision sensor products to high-end vision controller and camera products.
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Panther Vision provides independent consultancy and bespoke product development and is interested in joint development opportunities.
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Scorpion 3D Stinger™ Camera

The Scorpion 3D Stinger™ Camera is designed to be used in cutting-edge 3D Stereo Vision applications with or without structured light. It is compatible with the latest 3D version of Scorpion Vision Software and locates moving objects in 3D in real-time.

The unit is designed for serious 3D Robot Vision, 3D Laser Triangulation, 3D Gauging, 3D Assembly Verification and other advanced Machine Vision Solutions. It supports both passive and active stereo vision and is manufactured in two models - 30 mm and 200 mm baseline.

The 30 mm baseline unit can replace a standard 2D camera where a sense of 3D is needed for object location, measurement or assembly verification.
Preparing for measurement

Image quality has a major influence on the resulting measurements and is dependent on resolution, contrast, depth of field, perspective and distortion. These, in turn, are determined by the choice of system components including cameras, lenses and illumination. Cost is also an important consideration. The best components for the application should be used, but over-specifying them leads to unnecessary costs for no gain.

Back to basics

Since all the components in a machine vision system must be perfectly coordinated it is essential to make an initial evaluation of the application:

• What objects are to be measured?
• How large is the measurement area?
• What type of measurement is required?
• Are multiple views/measurements required?
• How fast are the parts moving?
• What measurement accuracy is needed?
• Is colour identification needed?

These and other factors help to determine the specification of the vision components needed, but there are also environmental issues that should be taken into account. These include physical constraints on positioning of components and environmental conditions such as ambient light etc. The resulting system does not need to be a complicated set-up, it simply needs to be fit for purpose.

Moving to 3D

With 3D machine vision technology becoming much more widely available, a similar process should be adopted when specifying a system to make 3D measurements. Although 3D systems have become much more affordable in recent years, they are still generally more expensive than 2D systems and add more data and more complexity so should only be specified when the required measurement can’t be made using 2D methods. With a variety of 3D measurement techniques available, it is also important to choose the method most suitable for the measurement application.

Making measurements

Machine vision measurements are made in software. For vision systems utilising a smart camera, the measurement software and measurement tools are built into the camera itself. For PC-based systems, there are essentially 3 main software categories that can be used with single or multiple cameras:

• Simple to use systems with graphical point and click interfaces often accessed via a web browser. These will feature a wide range of measurement tools that can be linked together to meet many measurement requirements.
• More sophisticated machine vision software that provides a much wider range of functionality and is frequently used by systems integrators to develop complete vision measurement solutions.
• Powerful programming libraries for development and implementation of vision solutions, primarily by vision experts. These feature a comprehensive collection of software tools and provide the ultimate flexibility for developing machine vision software applications from application feasibility, to prototyping, through to development and ultimately deployment.

Calibration

In order to make actual measurements, pixel values must be converted into real world values, which means that system calibration is required and the system must be set up to ensure that measurements can be made with the required accuracy, precision and repeatability. For the best repeatability, all of the set up conditions for the vision system should be recorded. These include: exposure time, camera gain, white balance of the camera, light intensity settings (and strobe, if used), working distances and angles and f-stop of the lens etc. A universal test chart can be used for quick and convenient system set-up and checking, for focus, system resolution, alignment, colour balance. Geometric distortions from the lens can usually be corrected in software.

3D calibration

Special 3D calibration bodies with known reference surfaces and angles allow metric calibration in combination with special software packages. They can be used for the simultaneous calibration of one or more cameras. In addition to metric calibration a plane fit for alignment of 3D point clouds is possible. This is important for 3D matching and for easy processing of range map images.

Keeping on track

It is important to check the accuracy and repeatability of a vision system. One way of doing this is to perform a series of 30 measurements of the same part with automatic or individual part feeding, and check the variation of the results measuring the same part compared to the allowed tolerance. If this is acceptable, it sets a benchmark for future measurements and many machine vision systems offer extra statistical information, such as minimum, maximum, mean, std. dev., cp and cpk of measured values. The stability of the system can be checked by performing measurements with the same equipment at the same place and the same operator but at different times. It is also important to monitor machine vision results periodically to guarantee measuring tool reproducibility and this can be done by making test measurements with a reference object or special calibration body.
Character and code reading and verification

Optical character recognition (OCR), verification (OCV) and code reading and verification are a major application area for machine vision. Ensuring alphanumeric codes (e.g. lot details and best-before information), 1D barcodes, 2D datamatrix codes and QR codes are correct can be critical for consumer safety and for product identification and traceability. Products can be tagged either by a stick-on label or by information printed directly onto them or onto the packaging.

Optical character recognition

OCR tools use some pattern matching techniques such as pattern finding and contour detection since an alphanumeric character is simply a pattern that needs to be recognised. Contour-based tools work well on text with clear backgrounds and can accommodate variations in scale and rotation with no loss in speed. Contrast-based tools provide more robust detection in applications where the contrast is poor or changing. Machine vision OCR algorithms need a fairly complete letter to decipher, especially if the text is structured. Once the character has been detected, OCR systems work by comparing a library of taught models to what is printed. The output from an OCR system is the alphanumeric string that has been read such as a use by date. Special consideration must be given for text that is written in a curved pattern.

Barcode and matrix code reading

Pattern matching techniques are used to locate the code and extract the data. However, to improve reliability, barcodes, 2D data matrix and QR codes have a built-in redundancy so the code can still be successfully read even if it sustains a certain amount of damage in a production environment.

Verification

Verifying that a barcode has been printed accurately is very different from simply reading the code itself. A good reading algorithm should be able to read poor quality codes, but a barcode verification algorithm should grade how well the code is printed. There are a number of verification standards that cover parameters such as symbol contrast, fixed pattern damage and distortion. Each result is then graded accordingly. Similarly, OCV is a tool used to inspect the print quality and confirm its legibility. The output from an OCV system is usually a pass or fail signal based on whether the text string is correct, as well as the quality, contrast and sharpness of the text.

Difficult surfaces

Particularly for codes and alphanumericics directly marked on a component, there can be challenges in acquiring a suitable image for reading and verification. This may be due to lack of contras, a reflective surface, a curved surface or some combinations of these. Even for codes written on packaging or labels there may be problems with contrast or reflections from shiny backgrounds. Therefore, just as in any other machine vision application, correct illumination is of paramount importance.
Ensuring production quality of vehicle parts

Trax JH Ltd based in Wales is a leading manufacturer of automobile wheel weights. These parts form a vital element in vehicle manufacture and the need for 100% accuracy in production is paramount for vehicle safety. To ensure all wheel weights are produced to exacting standards, Trax JH relies on Acrovision’s vision system within its manufacturing process to prevent any product defects or quality failures reaching its OEM customers, such as Jaguar and Land Rover.

Two Cognex In-Sight 7050 cameras operate on each of the two lines and are required to inspect the correct orientation and size of the part, of which there are approximately 30 variants. Placed initially in a bowl feeder, the wheel weights are automatically positioned on a conveyor, which are then ‘flipped’ onto their side before being presented to the camera to check for the correct orientation and size. One of the In-Sight cameras is placed above the line and inspects the length and width of each part to check it falls within pre-determined parameters, therefore ensuring the same sized parts are all contained within a single batch ready to be shipped.

The second In-Sight camera is positioned on the side of the conveyor to check the orientation of the part. This inspection process is vital to ensure that the adhesive tape applied at the next stage of production will be positioned correctly to ensure product quality. Once the adhesive tape is applied, the parts are collected in a box ready for dispatch. The reporting for each part inspection is collated and available for operators via Cognex’s VisionView visualisation tool used for analysing and managing the production processes for ongoing quality control.

The inspection system ensures each part is 100% accurate prior to shipment. It has significantly increased process repeatability and decreased PPM failures from the two production lines.

Innovative 3D Scanner reveals surface defects

Novel, compact portable 3D scanners have been developed by 8tree for different types of surface inspection. The dentCHECK identifies bulges or dents on any product surface such as an auto body, while fastCHECK is used to test fasteners in the aerospace industry, where for example every single rivet on the fuselage must be individually tested. The system not only recognizes faulty rivets, but also the fault type: too deep, too high, inserted diagonally. The clearances between two components – such as those in vehicle assembly are measured by gapCHECK.

The completely self-contained scanner is the size of a small, compact suitcase and can be mounted on a tripod. All the components are integrated inside this housing: projector, camera, computer, etc. In a novel approach, the built-in projector is used to project not only the structured light pattern onto the tested surface, but the presentation of the measurement results as well.

Using structured light projection, a series of strip rasters is projected within 0.1 seconds onto the test object. The projection is captured by a Manta G-031B monochrome camera from Allied Vision with VGA resolution and a 125 fps image rate and the images are then analysed using image processing software. The raster’s deformations on the surface deliver precise information about the surface’s condition: irregularities, dents and bulges can be identified and measured with an accuracy of 50µm.

The measurement results are available within seconds and are projected directly onto the object. If an irregularity is located on the surface, it is colour coded to show whether it is a bulge or a dent. Thus, the user can tell immediately whether a fault exists, where it is located, and what type of fault it is. Finally, exact values such as the diameter and depth of a bulge are provided as text information.

Airbus in Germany and Great Britain is using fastCHECK to contribute to aircraft safety by checking the correct position of fastenings on aircraft wings, for example.
Alrad Imaging has developed a simple vision inspection system that facilitates tungsten electrode positioning on lathe welding systems from Weldlogic Europe Ltd. Weldlogic Europe is a leading supplier of products and solutions for micro-joining applications in a broad range of industries including sensors, aerospace, medical, nuclear, micro-electronic, battery and motorsport. Accurate positioning the tungsten electrode over the joint line prior to welding is of critical importance and can be very time consuming.

The vision system from Alrad consists of a Sentech STC-P63BJ colour PAL CCD camera coupled to a Ricoh FL-CC1614-2M 16mm machine vision lens plus a video monitor and can be used for both checking the position of the tungsten electrode and also monitoring the progress of the welding process if required.

The camera features an automatic shutter which ranges from 1/50 to 1/100,000 second. This copes very well in compensating for the intense arc produced during welding, although optional filters can be added if required. Users of the vision system, report that it has reduced the set up time considerably and also resulted in a reduction in the number of scrapped components and re-welds, which ultimately has reduced manufacturing costs.
Vision Software
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www.matrox.com/da4/ukiva
Recent systems built by Altec Engineering to perform assembly operations on automotive windscreens, clearly demonstrate the diversity of concepts and applications where machine vision can provide a robust and cost effective solution.

Altec is a designer and manufacturer of special purpose equipment, with expertise in the integration and application of machine vision to component inspection, validation, generation of positional offset data, either within bespoke assembly systems or in conjunction with robots.

A pair of machines have been designed and built by Altec for car windshield inspection. The system is designed to produce a range of component variants and uses interchangeable fixturing, which is coded to allow automatic selection of the correct machine programme and sequences.

The individual components, which include rain sensors, perimeter trim, brackets and clips, are manually loaded to the assembly fixtures by the operator. The glass is then also loaded and the automated sequences begin when the operator presses a two handed start system. The machine uses a series of sensors and a Keyence vision system to check alignment and the presence of all the required components, before Siemens servo systems use the machine vision data to position the brackets to match the glass orientation. With everything checked and in position, the system initiates an ultrasonic welding sequence, powered by Dukane equipment.

This machine is an excellent example of how machine vision can operate as a key element alongside a wide range of other technologies to provide a complete system solution.

Altec wholeheartedly embrace machine vision technology wherever it can be used effectively, and have integrated systems of varying complexity from a number of the industry’s leading suppliers.

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Inspection of can seal integrity

ClearView Imaging has partnered with a major manufacturer of 3-piece food and beverage cans to develop an inline system to measure the can body after the seam weld to look for alignment issues. If the welded sections are not correctly aligned then the can seal can fail, leading to expensive product recalls if the can fails after reaching the consumer.

To ensure proper alignment, the position of the can edges relative to one another must be measured with an accuracy better than 20um. The measurement must be done while the cans are moving at a speed of up to 90m/min, so with up to 12 cans per second, 24 inspections per second are required. To ensure the best measurement resolution a telecentric lens was required. Unfortunately, many with a suitable field of view (40-50mm) perform poorly with high-resolution sensors. To determine the best lens for the job, extensive testing was done both with MTF test charts and on actual products. The final choice was VST’s TCM-025-150, having a magnification of x0.25 and a working distance of 150mm. This keeps the optics clear of the fast moving cans and gives plenty of space to accommodate the lighting system. The lens is paired with a Point Grey Grasshopper3 6MP (GS3-U3-60S6M-C) camera giving an overall system resolution of 18um.

However, the resolution of the lenses and camera system would be completely wasted if the images of the cans were blurred. At maximum speed the cans move 1.5mm in 1 millisecond which is unacceptable for a system expected to measure to around 20 microns. An exposure in the microsecond range is required to ‘freeze’ the motion. A strobe solution is vastly more efficient than continuous illumination, but still challenging in terms of the intensity required and the short duration of the illumination pulse. ClearView Imaging therefore developed a custom LED illuminator coupled with a high power strobe driver to deliver the high intensity short duration pulses required for this application.

USB cameras help improve laser marking precision

IDS USB 2 uEye SE industrial cameras are among those used by Rofin-Baasel Lasertech in its EasyMark desktop laser marking systems, used for the engraving of metal or plastic parts in DIN A4 format up to a height of 120mm. Camera solutions help make the marking process as precise as possible and avoid the creation of scrap. In the basic system a 2 MP camera mounted laterally above the workpiece to be engraved, supports manual workpiece positioning.

This can be enhanced with the Rofin SmartView solution, which uses a 10 MP camera to display an image of the workpiece as a background in the engraving software. This allows easy orientation of the information to be engraved independently of the workpiece’s position. This is particularly useful where the surface to be engraved cannot be defined using a positioning rectangle or if a test engraving is not possible due, such as circular engravings on high-quality watch backs or engravings on coated workpieces. A relatively inexpensive lens with a fixed focal length provides both an overview image and a pin-sharp detailed image. The camera’s high resolution enables easy digital zooming on the image and precise adjustment of the engraving’s layout.

A third, ‘Through-the-Lens’, option features a 10 MP camera “looking” through the deflection mirror and focusing lens along the laser’s optical beam path to capture all optical and electrical fluctuations in laser beam deflection and focusing in the system. These are adjusted automatically when positioning the engraving layout using the camera image giving extremely high precision.

The IDS Software Suite is identical across all IDS cameras, whether they have a USB 2.0, USB 3.0 or GigE interface, making it very easy to integrate the cameras into Rofin’s own Visual Laser Marker engraving software, with all cameras in the range completely interchangeable. If a system needs different cameras to meet new customer requirements, the camera-specific parameters can simply be adjusted without re-programming the Rofin application.
Multi-camera vision system monitors underwater military operations

A vision and recording system that uses multiple industrial cameras has been developed by NorPix in order to monitor underwater explosions in Europe. The solution uses StreamPix Remote to manage 18 x 10GigE cameras from Emergent Vision Technologies in waterproof enclosures. The setup uses 5 PCs for uncompressed recording from up to 4 cameras each, 2 PCs for compressed recording, and one PC for remote control and real-time display. All camera-to-host connections are by 30- to 150-metre fibre optic cables, each on a 10GigE network. 10GigE (10 Gigabit Ethernet) is the successor to 1GigE (1 Gigabit Ethernet) which is the leading interface for machine vision applications. 10GigE provides all the benefits of 1GigE but with a ten-fold increase in data-rate which leads to a ten-fold increase in frame rate.

StreamPix software enables users to view, control, and acquire images from multiple cameras simultaneously, all in the same user interface. It provides a management console for the cameras and provides tools for setup, control, and acquisition.

Each of the front line computers records a total of 2.6 GB data/second from four HD 1920×1080, 338 fps cameras in uncompressed RAW8 format. Every 24th frame (1 in 14) is decimated to half resolution (960 x 540) and real-time H.264 compressed so that a live stream is delivered to 2 secondary remote recording stations at about 50 megabits/second. The H.264 compression is GPU accelerated. The remote PC controls recording and playback, as well as gain, exposure, and white balance for each camera. It also allows control of focus and iris. Dual large monitors provide a tiled display of all cameras plus a large display of a selected camera directly on the 2 secondary recording stations.

Smart cameras bring zest to intralogistics for high-bay warehouses

Sensors from Leuze electronic are particularly useful in automating the logistical flow of material goods in high bay warehouses. The LSIS 472i smart camera, a special device type within the LSIS 400i smart camera family, is intended for compartment fine positioning in high bay warehouses, mainly in double-deep shelves. LSIS 472i detects circular holes or reflectors and determines the position deviation in the X and Y direction relative to the target position.

Up until now, several photoelectric sensors were necessary for this application. Now, the user only requires one camera per double-deep pallet compartment. The integrated illumination with powerful infrared light means that there is no interference from any ambient light often found in warehouses. This solution reduces the cost of wiring and mechanical mounting. The M12 connector makes installation with ready-made cables easier. Teaching a hole position using teach mode is quick and simple. The camera can be configured via the browser with webConfig so no separate configuration software is necessary. This makes start-up considerably easier, because costly alignment, configuration and testing of the sensor system are not required. Errors during start-up are significantly reduced. Image transfer and the associated process monitoring during operation take place via FTP. The camera has integrated interfaces for field buses and industrial Ethernet, and also for RS232 and Ethernet TCP/IP. 8 configurable digital IOs are available in total, e.g. for positioning the HBSD.

High speed measurement of small components

Since 1997 Multipix Imaging has been working with Envisage Systems Ltd, a leading supplier of industrial vision inspection systems. Envisage Systems have developed a highly successful system called CAPVIS which is a prime example of an automated vision solution for measurement and inspection.

CAPVIS is used to inspect extremely small components such as surface mount capacitors, which are almost impossible for a human to measure or inspect as they are very difficult to handle and also too small to measure accurately with mechanical devices. The speed at which these components need to be inspected, approx. 6 per
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second, is impossible for human operators which re-enforces why machine vision is used in this classic manufacturing example.

The system comprises of six Basler acA1300-60gm 1.3MP GigeVision cameras that are used to inspect all six sides of the capacitor. The measurements on each side include over-all component dimensions, dimension and total area of the terminal pad, pad alignment and surface defects on the capacitor body and termination pads.

The application software uses MVTec’s HALCON for the image processing while at the front end there is a highly developed and customised operator interface for configuration and monitoring.

OLMEC-UK  
www.olmeck-uk.com

Vision system ensures full steam ahead for microwave packaging

Olmec-UK has developed a web-mounted vision system for a manufacturer of microwaveable packaging to check the presence of laser micro-perforated holes and that the perforations have gone through completely. The packaging, used by a number of leading ready meal manufacturers, features arrays of laser micro-perforated holes covered with a hot-melt patch which act as self-venting steam valves. As the pack is heated in the microwave, the steam produced creates pressure in the packaging, rising to the optimal level for steam cooking. At the appropriate time, the hot melt melts, exposing the holes to allow excess steam to escape. This prevents bursting while maintaining the optimal steam pressure in the container.

The vision system consists of six line scan cameras mounted in the correct position to inspect 6 ‘lanes’ of perforation patterns as they pass under the camera to provide guaranteed 100% web coverage in the machine direction. The system measures holes with diameters of 350 – 1000 µm at web speeds up to 200 m/min. It checks that they are at the size, pitch and repeat that was entered into the user interface as well as being

continued on page 28
fully perforated. The system is fully integrated into the web, so if the holes are not detected or they are incomplete, the web is automatically stopped. The packaging material is illuminated from the back, so the cameras see the transition in light intensity when it comes through the holes, meaning that it can be used for both clear and overprinted packaging film.

The vision system is triggered independently of the laser perforation process so that if there is a failure of the print registration sensor used to fire the perforating laser at a specific location on the artwork, the vision system will still inspect the web and stop the line if the holes are not detected.

RNA AUTOMATION www.rnaautomation.com

Vision system inspects laser drilled holes

A novel 4-stage vision inspection system from a collaboration between ES Technology Ltd, RNA Automation and Fisher Smith has been deployed to measure the location and entry and exit sizes of laser drilled holes in a plastic part used in gas detectors for the mining industry. The size of these holes critically affects how accurately any sensor fitted with the part will be able to operate.

The system was required to accommodate eleven different variants of plastic parts, with hole diameters ranging from 15um to 50um. It also needed to allow a rapid exchange of tooling of the parts between each of the component runs. After inspection is completed, the part is dropped into either a pass or reject chute depending on the overall results of the inspection.

At the first inspection station, a vision guided robotic system identifies a part from the feeder system by matching its image to a template acquired by the system and places it onto a fixed position on a walking beam transfer system. A UV laser drilling system drills hour glass-shaped holes into the part, after which it is moved through three further vision inspection stations. Each of these 3 stations utilised 4 Mpixel GigE cameras, ring lights and telecentric lenses. At the second vision station, the location of the drilled hole is determined to ensure that no rotational errors had been introduced before the drilling process.

The third inspection station for entry hole measurement overcomes the difficulties in measurement posed by the unique hour-glass shape of the hole, the potential variation in thickness of the parts by up to 100um and the limited depth of view, by using a servo driven precision ball screw slide to move the camera 300 µm vertically in 5 µm increments from a pre-programmed starting position. An image was captured at each position. These sixty images are analysed to determine which contains an optimally focused image of the entry hole and this is used for measurement. The procedure is repeated for the exit hole at the final vision inspection station using a similar camera configuration to measure the bottom of the part. If the surface at the exit point is too rough for adequate illumination, through-the-hole illumination is used instead.
Track shoe pallet picking using 3D

Scorpion vision has successfully developed a 3D robot picking system to pick track shoes of the type used in armoured vehicles and bulldozers etc from pallets. Using Scorpion 3D Stinger technology, a dense 3D points cloud is generated together with a high-resolution 2D image set. Since most 3D point clouds contain much less information than a 2D image, 3D data is extracted from the 2D images allowing the required 3D location to be identified before making measurements using the 2D data.

The system was required to locate the shoes in pallets 1200 x 800 x 800mm in size and verify the final picking position. The system has to accommodate more than 20 user configurable shoe variants, including single, double or triple grousers type with an automatic product change. The system features a Scorpion 3D Stinger stereovision camera mounted on the robot and equipped with an IR laser random pattern projector (RPP) to guarantee that the object has sufficient texture for robust stereovision calculations.

Initially all features are located in 2D and then converted into 3D by using the RPP and stereo images to generate a dense 3D image. Multiple objects are located and segmented in the dense 3D image and the pose (x,y,z,rx,ry,rz) of the objects are calculated. This pose is used to extract the most accurate 3D coordinates from the very accurate edges in the 2D images - the basis for 3D in 2D. Using the object pose, a 3D reference is easily created for each object plane. Once the object plane is located in the 3D image, measurements are switched to the 3D calibrated 2D image object plane. This is because the 2D image contains a lot more information than the 3D image, since the 3D resolution is limited by the RPP dot number and size.

Vision system steps up to the oche!

Flight Club Darts is a highly popular social darts venue in London. Social darts puts a new twist on the popular pub game by combining a highly sophisticated, patent applied for ‘Flight Path’ vision-based scoring system with the ‘Flight Deck’ game management system featuring impressive game play animations. With billions of calculations completed in just a fraction of a second, the system is so fast and seamless that players never have to wait for scores to be computed no matter how fast they can throw!

Developed by Vision Experts, in conjunction with Stemmer Imaging, Flight Path consists of the dartboard, three AVT Mako G125C GigE cameras running at 10Hz and producing colour images of the dartboard, custom circular surround lighting, a high-spec quad-core PC and a gigabit switch.

A normal dart impact on the board triggers 3D fitting algorithms to identify, recognise and measure the precise position, pose and score of the dart to within a fraction of a millimetre. The vision system looks for the exact shape of the dart, which has been carefully modelled in 3D. Using multiple cameras reduces obscuration effects, with a full 3-D pose estimation result accurate to 0.2mm produced in under 200ms, thanks to specially written model fitting algorithms. Cheating is impossible as darts cannot be hand placed quickly enough to simulate the visual impact of a thrown dart.

Provided the cameras are pointed approximately correctly, the software will recognise and self-calibrate the cameras using a custom calibration algorithm that fits the virtual board wire to the observed image of the dart board itself. Unskilled staff need only orient the cameras approximately then the software takes care of the rest.

The lighting surrounds the board 360°, which minimises shadows and also looks aesthetically good for the venue. The cameras are sensitive enough to cope with even the minimum illumination when the venue lights go down in the evening.
Some useful technical tips from UKIVA members

Understanding laser-based 3D triangulation methods (Alrad Imaging)
www.alrad.co.uk/datasheets/Imaging/Understanding%203D%20laser.pdf

Pixel preprocessing or RAW format (IDS Imaging Development Systems GmbH)

Finding the right digital camera for your microscopy application? (Multipix Imaging)
multipix.com/whitepaper/microscopy

Beyond GigE Vision speeds – Teledyne DALSA Turbodrive – how it works (Stemmer Imaging)

EVENTS & TRAINING

EVENTS

Multipix Imaging - Vision Without Limits
26th April 2016, City West Hotel, Dublin
28th April 2016, MTC, Coventry
A technology event illustrating where and why machine vision is so successful and integral to everyday life.
www.multipix.com/events/

The PPMA Total Show - 27 - 29 September 2016, NEC, Birmingham
Many UKIVA members will be exhibiting at this extended event.
www.ppmatotalshow.co.uk/

Photonex - 12 – 13 October 2016, Ricoh Arena, Coventry
UKIVA will present a program of free seminars: ‘Industrial Vision Works! - techniques, and applying imaging technologies’
www.photonex.org/

VISION - 8 – 10 November 2016, Messe Stuttgart, Germany
UKIVA will have a stand at this show and several UKIVA members will be exhibiting
www.messe-stuttgart.de/en/vision/

TRAINING

Training courses offered by UKIVA members:

Scorpion Vision
‘Scorpion Vision Basics, Scorpion Compact Vision & Scorpion 3D Stinger’
April 13 – 15, 2016, Oslo - docs.tordivel.no/STR/

Stemmer Imaging (in association with the European Imaging Academy)
‘Optics and Illumination’ April 20, 2016
All courses at Tongham, UK - www.stemmer-imaging.co.uk/en/events/training-events

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