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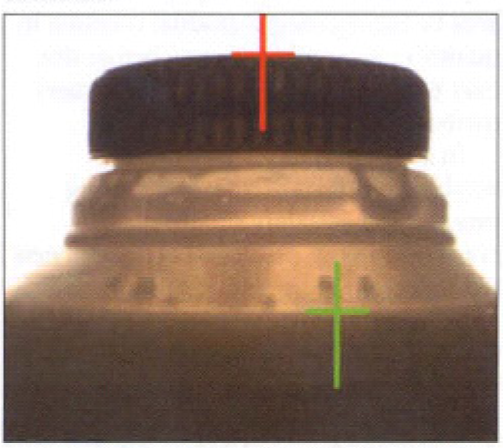
Taking a view on machine vision systems

Richard Thornton

It is no longer practical to use human visual inspection to meet the demands of a continuous 100% inspection regime when the latest machine vision systems, no larger than a standard optical sensor, are capable of some very detailed inspection methods, and they never tire

During the past decade demands for manufacturers to provide ever more cost-effective products have continued unabated. Customers demand that prices fall, but at the same time insist that quality levels increase. This situation can be a major problem for manufacturers to comply with since they must not only produce improved goods but they must also show evidence of increased quality.

Equally, the general rule of mass production is 'the higher the quantity, the lower the cost', so as production output increases quality comes under even more pressure. As a consequence it is no longer practical to use human visual inspection since humans cannot cope with the demands of a continuous 100% inspection regime or provide the 24 hour feedback necessary to take preventative action once a quality problem is identified.



Checking for cap presence and fill levels

For these reasons much research and investment has been made in the design and utilisation of industrial Machine Vision Systems (MVS). These allow 100% visual inspection to be achieved and have become a ubiquitous part of most modern production methods due to their ease of use and reducing costs.

The world of vision systems and image processing has made rapid strides during the past ten years in keeping with the general increases in processing power, speed and memory capability. Moving away from the large mainframe computers and customised software of older generation visual inspection set-ups, the latest MVS start with units no larger than a standard optical sensor - but none the less they are capable of some very detailed inspection methods, computation of the analysed data and judgement criteria.

Applications

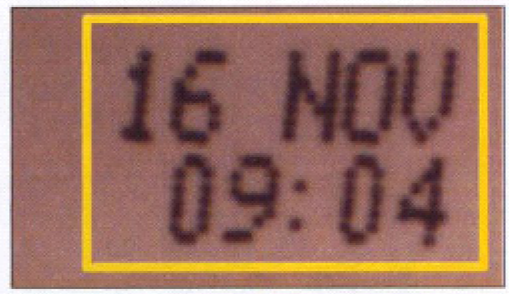
The range of industries that utilise MVS is very wide. Currently, the food industry is a major user where the systems are used to visually confirm the presence of labels and date codes on tins and bottles. Systems can also check the integrity of seals and canning processes. Food ingredients and features can be inspected, such as bad black peas in a bed of good green peas, or the visible fat content in bacon.

The production of electronic components makes copious use of MVS in the checking of linearity and co-planarity of connector pins, presence and length of leads and quality of solder joints. Optical character recognition (OCR) can provide proof of the correct nomenclature and serial numbers, while final package inspection can count the correct quantity of components in a tape and reel or box format.

Pharmaceutical uses vary from the counting of tablets within blister packaging through to bottle seal integrity and batch number identification. On the production side hypodermic sharpness, catheter quality and piece parts for artificial heart valves have all been successfully inspected using MVS.

High speed applications include 'on the fly' checking of samples within a centrifuge, canning applications where speeds can reach 1000 checks per minute and more singular applications such as checking for imperfections on a rotating tyre wall.

However, the vast majority of MVS systems are basic presence and dimensional checkers that most production cycles require on an ongoing basis to allow them to offer the customers the highest quality product with the lowest failure rate.



Recognition or verification of printed text

Principle of MVS

For those not initiated with MVS, the basic principles are fairly simple. The system comprises an image capture element that is usually based around a high resolution CCD (charge coupled device) - similar to those found in everyday compact digital cameras. This provides an image that can be interrogated and analysed by specific image recognition software that in turn produces a number of configurable judgement modes, or performs calculations on the identified image. The output of a MVS can be simply a pass/fail mode or, as in the case of more sophisticated manufacturing processes, it can provide detailed information on dimension, quality or colour of a manufactured unit. Such information can be exported by the system through standard Ethernet protocol or serial interfaces so that it can be used to alert or inform a fully integrated manufacturing process. Equally, on a stand-alone basis it can inform an operative of a problem item or activate a reject mechanism.

Implementation

The first step needed to consider the implementation of a MVS would be the identification of an overall aim for the project. On first considerations this may seem obvious - to inspect a manufactured item to ensure a perfect item is being produced. However, this needs to be broken down into various stages to avoid an unreasonable, or unobtainable, target being defined. Many experienced users of MVS recognise that, rather than ensure a perfect product, many systems simply highlight a defect that may prove impossible to rectify without a complete redesign of the manufacturing process. Equally, a quality assurance system set up to ensure 99% compliance may only allow a 1% pass rate. This would probably prove unacceptable to any production line manager. Therefore the first consideration must be the willingness to accept the information that the MVS offers and use or dismiss the information provided in the best way to ensure a rise in the quality of production rather than as an absolute deciding factor.

The actual checking functions to be utilised are a prime consideration. These

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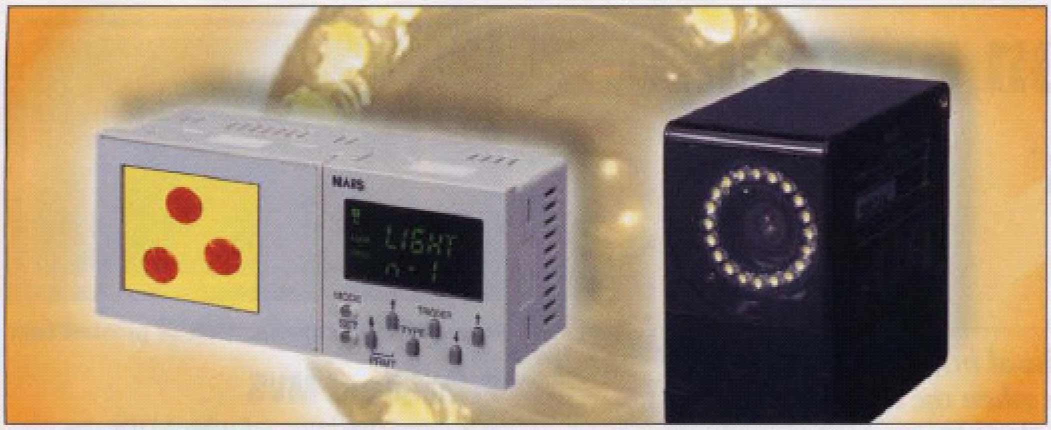


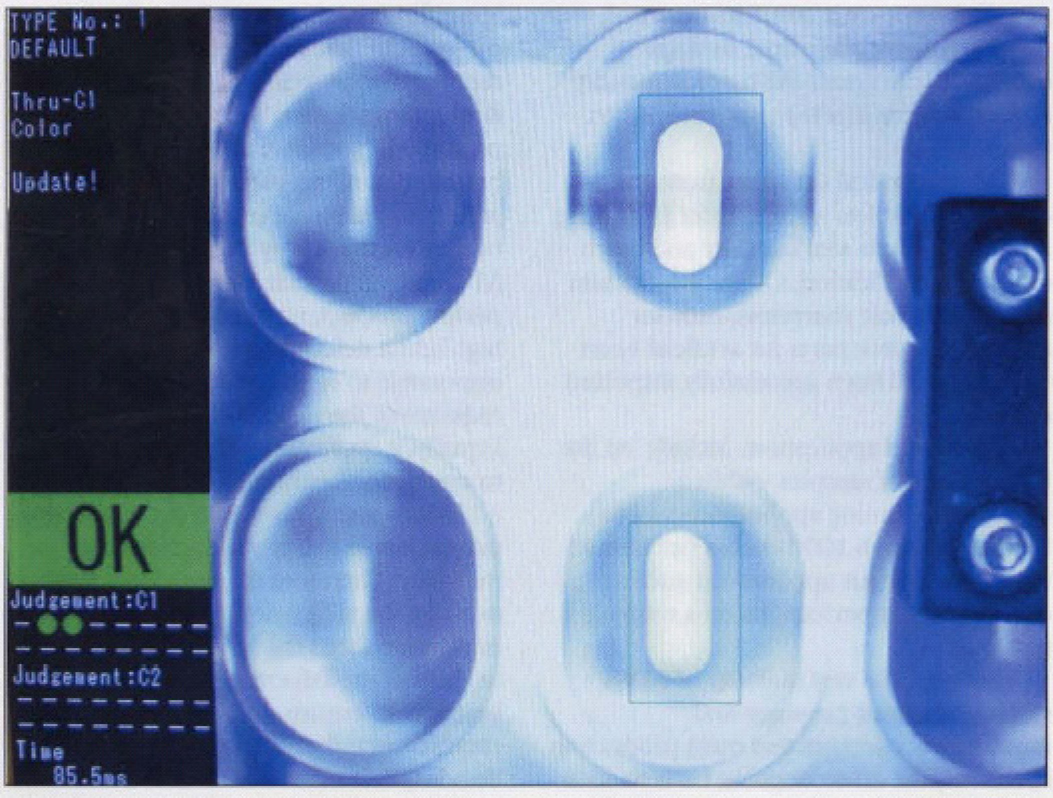
Intelligent Vision Sensor from Matsushita

can range from a simple presence check - for example labels on bottles, presence of an item inside a container or lids on packaging - through more complicated shape analysis or counting functions. From this initial check it is then practical to attempt to discriminate between different colours and shades or irregular features and even apply 'fuzzy logic' to identify a generality. A good example of this is the checking of fruits where the colours and shapes are not exact but fall into a general pattern of acceptability.

The physical considerations of an MVS should be considered at this point. In order to operate accurately an MVS will need a clean operating environment that can be isolated in terms of ambient light and possible manual interference. Although many systems are intelligent enough to counteract a gradual change in lighting conditions, very few can offer ideal checking accuracy without some form of artificial light source. This implies either lighting from the camera axis or providing a back lighting source in the event that silhouette dimensional images are required. This means that some care and consideration is going to be needed in order to choose suitable sighting for the system.

Because a finite time is required for the capturing of the image, processing and information output inspection speeds and cycling times are of great importance. In processes where the product is continually moving past the camera the capture time is very important in order to obtain a clear, un-blurred, image. The higher the speed the greater the degree of lighting consistency is needed. Due to the flickering nature of mains electricity driven fluorescent lighting high frequency inverted light sources are utilised or DC driven LED lighting units.

Typically, CCD cameras can capture images in less than 10 milliseconds with the correct lighting conditions. Where the product can be halted and an image captured the processing time becomes the more important criteria since the analysis and information must be completed before the next image capture commences. With the high speed processing available to a modern MVS, complex analysis in 20 to 30 milliseconds is not unusual. However, it is true that many applications do not require anything like this level of speed. The checking of larger items or sample analysis for example will very often have no time limit imposed within reason.



The clarity of MVS makes them suitable for detailed inspection work such as in this critical pharmaceutical manufacturing application

Costs

Although cost of ownership factors vary according to MVS technology and environment, costs are typically broken out into categories such as capital costs, technical support, and administration and end-user problems. Taken in context, the cost of ownership of a basic MVS is probably very low since the initial purchase price is akin to a high end optical sensor - maybe a thousand pounds or less. However the online support or in-house technical capability needed to support a high end MVS costing some tens of thousands can be considerable.

Since it is usual to rely on a working system the need to have adequate redundancy and backup systems available can push up the initial cost substantially.

Benefits

Of course, the overall benefits of utilising MVS can be highlighted in many areas. Accurate statistical information can be collated to allow production improvements to be qualified and monitored. Where continuous quality improvements or total quality management programs are in place, MVS analysis information can prove invaluable to the overall commitment to improvement by showing a time trend analysis of the production quality. Equally, they can show a possible problem area by highlighting a gradual decrease in quality in a specific area well before this may become visible by other inspection methods.

In summary, MVS can prove invaluable as part of a manufacturing process and certainly should be considered as an essential part of any new manufacturing process. Retrofitting an MVS may prove more problematic, depending on the age of the process and the nature of the inspection required but most reputable suppliers of MVS will demonstrate the capabilities of their systems in situ and may extend this to offering a loan system to prove the practicalities of such systems in the specific application.

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