Machine Vision Inspection Systems

Objective Quality Assurance in Packaging and Process Control
Executive summary

Product quality is important for manufacturers to maintain their brand image and create long-term relationships with their customers. Vision-inspection systems automate quality inspection and make it objective. Monitoring is in real-time, and goods that are not fit for retail shelves are rejected in line. These systems can also provide process control in applications such as sorting, picking and rejecting.

In recent times, the technology options for vision-inspection systems have increased, the cost of these solutions has reduced and hence the adoption has dramatically increased. Vision-inspection solutions, if implemented wisely, give manufacturers a competitive advantage, and can increase return on investment (ROI).

This paper examines the uses of vision-inspection systems and the many benefits for manufacturers, including improving internal processes and avoiding any rework.
Contents

Executive summary ................................................................. 2
What is vision inspection? ....................................................... 4
What are the benefits? ........................................................... 4
Introduction to vision-inspection systems in packaging .......... 6
Applications in packaging ...................................................... 6
Building an effective vision-inspection solution .................... 9
Choosing the right partner ...................................................... 9
The Matthews’ solution and integration ............................... 9
Summary ................................................................................. 10
References ............................................................................... 10
About iQVision ....................................................................... 11
About Matthews Australasia ................................................. 11
What is vision inspection?

The human eye, while capable and flexible, cannot make fast, precise and repetitive measurements. A machine-vision, or vision-inspection, system can.

Vision inspection is an automated, non-invasive and cost-effective technique to accurately, quickly and objectively check that goods meet the manufacturer’s specifications. It does this using cameras and software to visually inspect and analyse products against predetermined tolerances and criteria on a production line, in real time and without operator intervention.

Vision has uses across manufacturing industries, enabling these businesses to substantially lower costs, raise productivity, implement zero-defect manufacturing and excel in quality assurance (QA), thus the technology results in more efficient use of resources.

By implementing objective QA and enhancing process control, machine-vision inspection ensures that products meet the manufacturer’s quality standards.

What are the benefits?

Vision technology delivers these key benefits to manufacturers:

- automating quality control establishes a reliable system that delivers time and again; it also provides the ability to ensure quality based on specific parameters
- quality data is collected every time a product passes through for inspection; every product is monitored, and the information sent into production-management systems for process control
- throughput is improved and optimised, by providing the data that allows managers to react to upstream issues faster; the solution can also empower operators to fix issues to improve overall quality
- it results in cost savings by reducing waste and manual efforts

These systems also make it possible to demonstrate that reliable QA processes are in place to reassure customers.
Vision sensors can perform appearance inspections, character inspections, positioning and defect inspections.

Some of the major applications are:

- checking closures for tamper seals, correct caps by colour, dimensions, and so on
- inspecting presence, position and formation of a code, such as a date code or barcode
- validating presence and positioning of labels, as well as matching labels to other elements
- inspecting product for fill levels, product content, shape, size, and so on
- inspecting empty bottles, cans, tubes, boxes, tubs (and other rigid containers) to ensure they meet the dimensional and cosmetic requirements
- sorting products based on marking

Vision systems make sure products are labelled and filled correctly, are compliant, in-spec and shelf ready straight off the production line (products not fit for purpose are rejected). These improvements in turn improve return on investment (ROI), as well as provide data for continuous improvement and enable lean manufacturing.
Introduction to vision-inspection systems in packaging

Product and packaging quality is a critical component in achieving lean manufacturing. Vision systems have become an important tool on production lines to inspect this quality in real-time.

Manufacturers must check elements such as label, pattern, code presence and form in industries ranging from FMCG to pharmaceutical to avoid defective products reaching the consumer. If they do, it can lead to costly product recalls, damage to your brand and fines. An effectively implemented vision-inspection solution will significantly reduce the risk of incurring these unexpected costs that directly impact the bottom-line.

Because it amalgamates computer and camera technologies, vision automates QA, product tracking and control processes on production lines. Vision-inspection systems ensure that products consistently meet the manufacturer’s quality standards and specifications resulting in perfect product presentation every time.

These systems can inspect a wide variety of packaging and products, offering manufacturers peace of mind that their products are always in optimal condition when presented to their customers. For general applications, vision systems can inspect at up to 1200 products per minute (ppm), while for code-reading applications, the systems can inspect up to 2500ppm.

Why you should explore vision technologies for packaging:

• automating QA saves cost in rework
• automating quality provides objective (not subjective) QA, resulting in more reliable product quality
• there is greater transparency throughout the process, and improved process control
• it provides real-time, quality metrics, for overall equipment effectiveness (OEE) data

Applications in packaging

1. Code validation

This is a complete in-line solution that verifies code presence, position and formation. The solution is ideal for food, beverage, personal care, packaging or pharmaceutical applications. It will automatically identify and reject packages with missing, incorrect or unreadable codes to ensure only properly coded packages reach customers.

• date code verification: verifies that a code is present and is completely formed in the correct location, thereby preventing customer consumption of expired products
• batch code verification: ensures the quality and accuracy of printed date/batch information, it can also focus product recalls by enabling tracing of a single batch code
• bar code verification: verifies that bar codes are readable and correct, enabling proper product tracking through the supply chain and for recalls
• 2D data matrix validation: verifies that the non-human readable information is properly decoded and understood by the quality system to enable proper product tracking through the supply chain and for recalls
2. Label inspection

High-speed labelling of packages, ranging from boxes, glass and plastic bottles to aluminium cans, can produce a wide variety of defects. These defects can lead to label errors that can be harmful to a brand or even present liability issues for a brand owner. Labels can be inspected for label presence, wrinkles, tears and skewed labels, double labels, flagged or missing labels, and an incorrect label pair on packaging.

- **vision label inspection system**: can be set up to ensure perfect product presentation and confirm label ID every time; automatically inspects labels on all packaging, including bottles, vials, boxes, cans, trays and tubs; the system can detect and automatically reject packages and containers with label issues
- **label-match inspection**: inspects for front, back and neck labels, to check if they all match the product that is running
- **label match with other elements**: matches the label to other elements, such as caps
- **360-degree inspection**: with round labels, the inspection has to be 360 degrees since the bottle could be presented in any orientation; these systems can check wrap-around labels on wine bottles and other cylinders
- **label-presence verification**: inspects for the absence or presence of a label on a package or container
- **skewed label detection**: ensures that labels are applied straight and in the correct position
- **dog-ear label detection**: verifies that labels have been securely applied to the container or package
- **double label inspection**: ensures that only one label has been applied to the same location on the package
- **overwrap alignment inspection**: ensures that wrap-around labels are placed properly and applied straight (360-degree inspection can be used for this inspection, as per above)
- **graphical label verification**: inspects for unique graphical items on the label to confirm that the proper label is being applied
- **2D data matrix code verification**: confirms that the proper label has been applied by verifying the 2D data matrix code is present, or that the code has been printed correctly
- **barcode verification**: confirms that the proper label has been applied by verifying that the correct barcode is present, or that the code has been printed correctly

3. Closure and seal validation

Vision closure-inspection systems ensure the integrity of a closure before it is placed on a bottle, tub, or pack. They can check for aspects such as closure dimensions, liner integrity and decoration quality.

- **dimensional measurements**: verifies that closures are manufactured to the direct customer’s specifications to reduce content spoilage and leakage
- **reliability verification**: verifies the proper liner formation and placement to ensure the product is properly sealed and protected from contamination and leakage; it also verifies that the correct cap is used by checking colours
4. Packaging and filling QA

Vision-inspection solutions can automatically inspect filled bottles, trays, pouches, cases, cartons, kits and other packages to verify that the packaging process was completed to the exacting standards and specifications that the manufacturer set.

- **full bottle inspection**: checks that bottles are properly filled, labelled and capped to minimise product spoilage and ensure perfect product presentation for the retail shelf

- **case-pack inspection**: verifies that cases are properly and completely filled, sealed and marked, ensuring reduced packaging equipment downtime and full delivery to the customer

- **package seals**: ensures ready-meal trays are properly sealed to eliminate spoilage, leakage and contamination, so that a high quality product reaches the customer

- **product-content verification**: confirms that the specified contents of a kit are present, thereby demonstrating due diligence and reducing the costs associated with missing or additional kit components

5. Empty container inspection

Vision systems can inspect empty bottles, cans, tubes, boxes, tubs and other rigid containers to ensure they meet the dimensional and cosmetic requirements that customers and regulators demand. Containers not meeting these standards are automatically rejected to ensure perfect product presentation every time.

- **dimensional measurements**: verifies that containers meet manufacturing and regulatory specifications to ensure proper sealing and protection against contamination and spoilage

- **cosmetic verification**: confirms that containers are free from visual defects and contamination from the manufacturing process to ensure customers receive clean, appealing containers to fill

- **decoration inspection**: verifies that the printing and graphics are present, correct and properly formed, thereby protecting a manufacturer's brand image and ensuring customers get the product they intended to buy

- **tamper seal validation**: makes sure that the tamper seal is not broken
Building an effective vision-inspection solution

Vision-inspection solutions vary from very basic systems, which are economical and will check for code presence, right through to high-end solutions that can be programmed and configured to inspect a wide variety of quality measures as discussed in the applications section above.

Now that we have established how critical vision-inspection systems can be to ensure finished product quality, it is also important to choose the right solution for your production line by following these simple steps:

1. Begin with establishing the quality criteria that you would like to apply; ascertain which of these can be automated using vision systems. An experienced systems integrator or vision solutions provider can help with this process and can add value to the discussion.

2. Determine the product range, and what are the natural variations in product dimensions.

3. The next step is to determine the type of hardware systems needed to meet the application needs. It is valuable to determine what the system can, and cannot, do.

4. Make sure that the solution is trialled, not in a test environment, but on your production floor, to ensure that the solution will consistently deliver in the real conditions in your facility (under the lighting, line speeds, and so on).

5. Use the data from the inspection systems to improve your upstream processes so that the reject quantities are low.

What type of hardware is needed?

- vision hardware (cameras, controllers, illuminators, optics)
- peripherals (triggers, encoders, alarms, power supplies, other I/O)
- PLC interfacing and control
- mounting systems (design, integration, water and dust proofing, OH&S)
- operator displays
- warranties
- spare part availability

Due to the process-control aspects of vision systems, the system’s operator interface is critical to performance. Systems with a graphic user-interface are the easiest to use — operators simply select icons corresponding to the actions they want to perform. Screen prompts guide them through setup and analysis. Some characteristics of a good interface are the clarity and simplicity of defect-information presentation, and the ease of access to on-line program help. Some systems provide touch-screen graphic user-interfaces. The touch-screen is the most reliable system interface because it has no mechanical parts to break down.

Choosing the right partner

1. Before selecting a vision partner, assess their capability, past experience and range of implementations. Also check if they have the ability to service and provide space parts if necessary.

2. Work with the partner to determine what is possible, what is not possible, what is best practice, what is suitable for your production line and your processes (part presentation, control and feedback) and what are the constraints.

3. Make sure that the process established is reliable and repeatable to deliver objective QA.

4. Ask the partner to document the deliverable system and design, seek factory acceptance and site acceptance, so your team has a full understanding of what the system is designed to do, how it works and how it will benefit the business. Have a commissioning and integration plan to deliver the solution.

5. Work with the partner to train staff and have a plan to manage and modify the solution if needed.

The Matthews’ solution and integration

With iDSnet software managing the product-identification process (date codes, barcodes, batch codes, product labels, carton labels, pallet labels), manufacturers can rest assured that the right code is placed on the right product at the right time. Vision-inspection systems can be implemented as a part of the solution to verify code presence and formation. In the case of there being no code, the product can be directed to a reject bin or a different conveyor to get recoded. With iDSnet controlling vision systems, the quality aspects can be controlled and managed in real-time to avoid costly consequences.
In addition, iDSnet Manager can provide reports on reject rates, reject reasons and more.

Matthews has the experience, systems-integration capabilities and project-management competence to provide the most suitable inspection solution for your application. Matthews Australasia is also Omron’s preferred vision-system integrator in Australia.

Summary

Vision systems have become an important tool on production lines to inspect product quality in real-time. An integrated vision solution that complements your processes gives you a competitive advantage and objective QA.

Vision systems:
- reduce rework and wastage, hence
- make the packaging process leaner and more reliable, hence
- optimise profits for manufacturers.

Vision also provides the peace of mind that products will meet your customers’ expectations, including being functional and “shelf ready”.

References

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About iQVision

iQVision, a Matthews-affiliated company, is Australia’s first dedicated national vision-inspection solutions company.

The company brings together Australian Machine Vision’s (AMV) extensive experience with vision solutions, and Matthews Australasia’s systems-integration capabilities and project-management competence. iQVision works closely with Matthews on integrated product identification projects where vision inspection is needed, and operates directly with customers on vision-only projects.

iQVision provides reliable, robust machine vision-inspection solutions to Australian manufacturing industries, implementing objective quality assurance and enhancing process control. This gives peace of mind that products will meet an end customer’s expectations, including being functional and “shelf ready”.

iQVision has a wide range of vision solutions for industrial applications. These solutions are specifically designed to suit your needs and processes, and to achieve effective and lean manufacture. Developments in the technology have now made it accessible to small and medium-sized businesses, giving them greater opportunities in a competitive marketplace.

To find out more about how iQVision can be of service to you, call 1300 478 474, visit www.iqvision.com.au or email info@iqvision.com.au.

About Matthews Australasia

Matthews Australasia, a family business, is Australia’s leading provider of intelligent product identification and product-traceability solutions, offering inkjet, thermal transfer, laser, label applicators, label print and apply systems, RFID, barcode-scanning solutions and machine vision inspection. All these solutions can be integrated with Australia’s first identification networking and reporting software, iDSnet, winner of 2011 APPMA Design Award.

Solutions-focused, Matthews helps customers with business efficiencies and cost savings by providing production intelligence and increased automation. Matthews’ unmatched solution capability is backed by 24x7 technical support and customer service to support all installations across the country to give you peace of mind. Streamlining ensures less downtime for customers and Matthews’ first-time fix rate is 97%.

No matter what your coding, labelling or data capture application, Matthews is the only company in Australia that can provide you with a complete range of end-to-end intelligent identification solutions.

To find out more about how Matthews can be of service to you, call 1300 CODING (1300 263 464), visit www.matthews.com.au or email info@matthews.com.au.