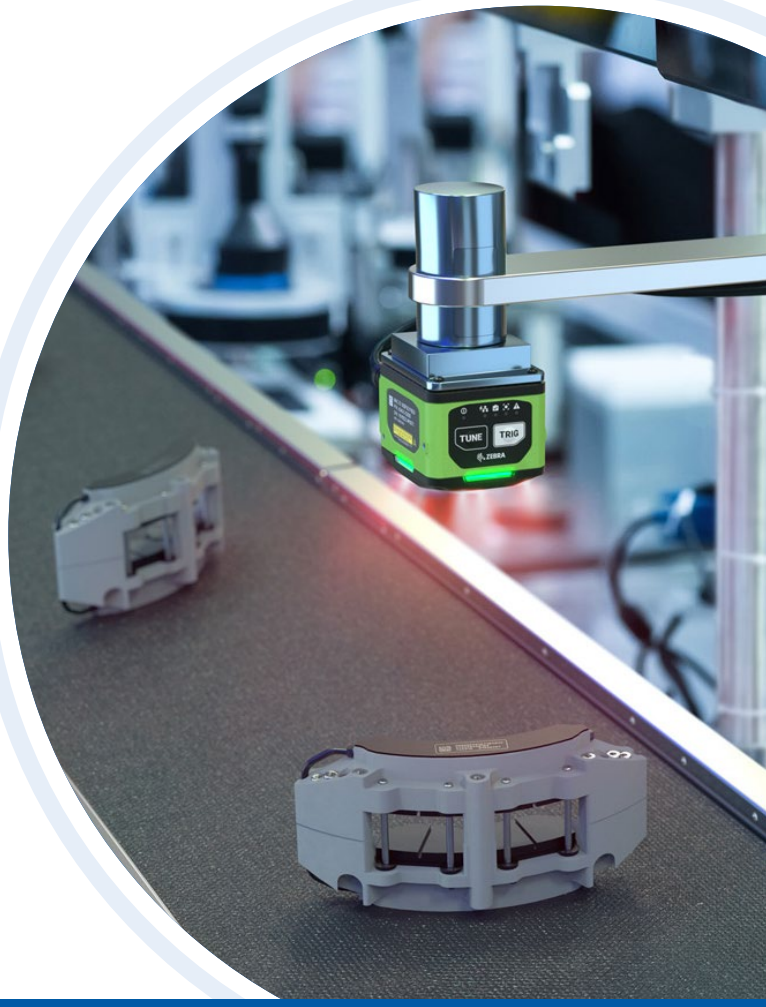
COBALT SYSTEMS

Machine Vision Beginner's Guide



Machine vision is a combination of computer science and engineering and involves the ability for machines to interpret and understand visual information captured in a controlled environment. It combines hardware and software to capture and process images, allowing machines to make decisions and perform subsequent tasks based on what it 'sees'.

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What is machine vision and how is it used in manufacturing

In a manufacturing or processing environment, machine vision has a lot to offer. It can be used to read text, to inspect components on an assembly line, identify quality control issues in packaging or labelling, predict maintenance schedules and much more besides.

Often these are tasks carried out by a person and given the repetitive, mundane (or overly complex) nature of the work are prone to error. And errors on a production line means lost revenue – whether that's caused by reworking faulty products, goods rejected by customers thanks to faulty packaging or spoiled goods, it's never a good thing.

Machine vision can help reduce a lot of these issues, but for many manufacturers, machine vision often strikes a note of terror. It's perceived as too cutting edge, hard to implement, expensive and quite frankly too much of a stretch for the majority of production lines.

But those perceptions are largely false. The technology is far from new, and in fact harks back to the late 1950s when scientists first theorised that a computer would be able to see images, recognise them and interpret information based on what it could see.

Although the hardware and software were not available to make this a reality until the 1970s, the theory held water and by the 1980s, algorithms for pattern recognition, object detection and image processing had been developed and were being used in industrial applications.

The next two decades saw incredible advances in two related fields; robotics and digital imaging. The former could be instructed to act on what machine vision systems saw and as digital imaging became more commonplace, the quality of images increased as did the speed with which images could be interpreted by corresponding software.

The final piece in the puzzle was the prevalence of deep learning and AI which allowed machine vision software to reference huge data sets to help in decision making. Now, almost a quarter of a way through the 21st century, machine vision has finally come of age. Equipment costs are lower than ever before, software is more advanced than ever before and ease of set up makes machine vision accessible for almost any manufacturing scenario.

In recent years, the real advancements have come in the brain behind the vision – image processing. Here, the magic happens through machine learning, a concept where machines learn patterns and make decisions. Improvements in machine learning have propelled machine vision forward, allowing systems to analyse images more accurately and faster than ever before.

How does machine vision work?

The key components of a machine vision system involves cameras for image capture, software for image processing and analysis, and hardware to integrate these elements and other equipment to perform tasks. Let's breakdown each element in more detail.

Image capture:

Modern machine vision systems use digital cameras to capture high-resolution images of the objects or scenes they are inspecting. These cameras are equipped with sensors that convert light into electronic signals, forming a digital representation of the visual input. Additional lighting or specific lens types may be required to ensure clarity of images depending on the situation.

Improvements in camera technology, including higher resolutions, faster frame rates, and enhanced sensitivity have significantly boosted the accuracy and speed of image capture. In much the same way as the camera on each new iPhone seems better and better, so it is with machine vision cameras. Highly advanced systems can even make use of thermal imaging, ultraviolet or 3D cameras for specialist applications.

Image processing:

Once the images are captured, machine vision systems use image pre-processing techniques to make the image as good as possible for analysis. Image pre-processing involves tasks like noise reduction (which is about removing the grainy look that digital images get when taken in low light) and contrast enhancement.

The second stage in image processing is segmentation and/or feature extraction. Both stages can be used together but don't have to be.

Segmentation involves dividing an image into different regions or segments based on certain characteristics such as colour, intensity or even texture. The goal of segmentation is to simplify the image into something that is more meaningful and easier to analyse.

Feature extraction involves identifying and extracting specific features or patterns from an image or part of a segmented image such as edges, corners or text. These detailed features and how they compare to what the system has learn is 'correct' are used to determine next steps.
To bring this to life, imagine a circuit board that is made up of dozens of components. A machine vision system could be employed to inspect each board as it passes along a production line and will split the areas of the board into segments and then extract relevant features to begin analysis.

Analysis and action

The processed images are then subjected to further examination and interpretation. This is where the machine vision system makes decisions based on predefined criteria or learned patterns.
For instance, in the quality control example of the circuit board, the system might identify a component that is in the wrong place or is the wrong colour or is missing altogether, all by comparing the captured images to a standard reference, learnt as part of deep learning setup.
Armed with this information, machine vision software can be integrated with other software and hardware features to then trigger certain actions. That could be as simple as a warning beacon to alert operators to an issue. Or it might trigger the production line to stop or divert that item into a separate stream for remediation. In very advanced assembly process automation, it might even guide robotic arms based on the visual input to correct the placement of components.
In short, the options for next actions are limited only by imagination and budget. But it is the speed and accuracy with which decisions can be made thanks to a machine vision system which make this a very real possibility.

Real life examples of machine vision in a manufacturing or production environment

With a good understanding of how machine vision works, let's take a look where the technology is making an impact in real life examples. In manufacturing settings machine vision can serve as an eagle-eyed quality control agent, far more capable and consistent than the human eye. Or in packaging standards machine vision can spot errors and issues and prevent wrongly packaged items ever being shipped out. Or in assembly production machine vision can make sure every item is correctly fitted in the right place, in the right orientation every time. Here are just a couple of examples of how machine vision can help SME manufacturers:

Quality Control

Let's zoom in on quality control where machine vision showcases its prowess. Imagine a bustling manufacturing line producing complex electrical components. Here, machine vision utilises both segmentation and feature extraction to isolate areas for inspection and subsequently detect potential defects, always ensuring that the right components are in the right place.

As the item moves down the assembly line, the machine vision system captures detailed images, examining every nook and cranny. It's on the lookout for imperfections like scratches, misalignments, or faulty components that could slip past the human eye.

If a flaw is detected, the system can swiftly trigger an alert, signalling for immediate attention. This meticulous quality control ensures that each item that rolls off the line meets the highest standards, providing customers with fit for purpose products and reducing the likelihood of defective products reaching the market.

Packaging Inspection

Machine vision ensures that every product that is deemed acceptable is wrapped, packed and labelled flawlessly.

Imagine a food production facility handling and packaging perishable salad leaves into wrap bags. If one piece of lettuce doesn't enter the bag and ends up breaking the seal, the whole bag can be spoiled. That single bag can cause an entire shipment to be rejected by the end customer causing a massive knock on effect in terms of lost time, destroyed product, shipping costs that can't be reclaimed and more. All because nobody spotted a piece of lettuce in the wrong place.

Machine vision is perfectly placed to deal with this scenario, diligently monitoring the process of bags being filled and sealed and rejecting unsafe bags to ensure that the whole batch is safe at all times.

Compliance Monitoring

In compliance monitoring, machine vision ensures businesses can adhere to regulatory standards and safety requirements without needing to hire staff working across every shift to monitor things by hand.

In an environment where compliance standards drive what is considered acceptable – for example a pharmaceutical setting, machine vision is incredibly helpful. Imagine a scenario where tablets or pills have to be packaged in a fixed quantity and then be correctly labelled in order to be compliant.

Machine vision can step in to examine each tablet as it progresses down the conveyor belt, checking for damage, quantities and accurate labels, properly sealed bottles or any other signs of damage.

If anything is compromised, the machine vision system immediately flags it for corrective action.

Reading text or barcodes (character recognition)

In an environment where date codes are applied to packaging, it's vital to know that the information is correctly applied each time and is legible to the human eye.

Machine vision excels in such an environment. Modern software is able to easily recognise date, batch and other relevant information for FMCG and perishable goods to ensure the right information is applied to packaging.

Taking this a step further, if the information on a package is outside of the scope for that particular batch, an item can be rejected and action taken to remove it from the production line ensuring consistency and quality of goods throughout the supply chain.

Assembly Process Automation

Machine vision has the capacity to revolutionise the efficiency of putting together complex products. Imagine an automotive assembly line, with components moving rapidly down the conveyor belt. Machine vision takes charge, analysing each part with precision as it arrives.

In this scenario, the system can guide robotic arms to perform intricate tasks, such as precisely placing bolts or attaching components, and not just the same repetitive process time and time again. Each interaction can be different. The machine vision system ensures that every step in the assembly process is flawlessly executed, minimising the risk of errors and optimising production speed.

But machine vision in assembly processes doesn't need to be as complex as controlling robotic arms. In smaller firms, machine vision can still ensure that the system is running smoothly by checking each stage along the way. By automating these tasks, assembly process automation with machine vision not only enhances accuracy but also boosts productivity, allowing manufacturers to create high-quality products at a faster pace.

Predictive maintenance alerting

One area that is almost an offshoot of a machine vision system is in the ability to predict when machine maintenance is required. Take a situation where hundreds of components are made on a production line every day. If the failure rate of that component increases beyond normal standards then it is highly likely the machine responsible for that element of manufacturing is also going to fail. Thus monitoring throughput quality provides an opportunity to not just stop bad products being despatched, but also the chance to identify and resolve the manufacturing fault.

Machine vision mythbusting

As stated at the very top of this blog post, there are a lot of misconceptions about machine vision:

“They cost too much” … “The technology isn’t up to it”…“They take days to set up or reconfigure” … “they’re just not worth the investment”…

Step back in time 10 – 20 years and at least some of those statements were justified. Now, that’s simply not the case.

In terms of cost, an entry level machine vision system is not expensive. While it’s hard to put exact figures on a theoretical system, if the goal of machine vision is to check the sell by date and code on every box leaving your factory and that task is currently being handled by a person, it’s safe to say the ROI will be in months not years.

As for whether the technology is up to the task, at Cobalt we primarily use Zebra Machine Vision systems and the investment Zebra have made in this area is staggering. With a range of cameras, plug and play software and enhanced support, machine vision has never been better.

The same applies when it comes to how long it takes to set up a machine vision system. Not many years ago it would be commonplace to expect to take several days to set up a system to perform relatively simple tasks. With Zebra’s machine vision cameras and software, it literally takes minutes from unboxing to being online.

From the advancements in image capture, driven by cutting-edge camera technology, to the powerful strides in image processing through to accurate analysis thanks to deep learning, we’ve glimpsed how machines are gaining the ability to see, understand and direct the visual world around them.

Instead of having full-time staff employed in the roles machine vision can perform, such as quality inspection or compliance monitoring, machine vision systems can perform the tasks tirelessly and with unwavering accuracy across multiple shift patterns.

For more information on how machine vision systems could boost your operations’ productivity and how it could make a real difference in your business, get in touch with the team at Cobalt. We’re always more than happy to help and can’t wait to talk to you about what machine vision could do for you.