THE MACHINE VISION PLAYBOOK

The complete guide to planning, building, and maintaining a machine vision system that can 2x your factory.
Quality control is no longer optional

As the driving force behind innovation and competition, quality assurance can not only save time and money, but it can also ensure customers remain confident in your products and loyal to your company.

The rise of Industry 4.0 and the advancement of smart factories have changed the way industrial manufacturers think about quality assurance.

Machine vision has quickly become a favored solution to help identify and remedy quality issues as they arise. It’s a versatile, reliable, and cost-efficient solution to problems that can plague any manufacturer. Machine vision can provide a new level of transparency and an additional checkpoint to ensure quality, production efficiency, and manageable costs in your process.
Machine vision capabilities

Machine vision systems are able to read in two ways.

**Optical character recognition (OCR)** is the ability to recognize alphanumeric texts reliably at high speeds. Characters are inspected, then compared or matched against a database of characters.

**Optical character verification (OCV)** is the ability to verify that the characters are exactly what they are supposed to be. This requires prior knowledge about what the specific alphanumeric pattern is so the system can validate. These two abilities allow machine vision to perform a variety of reading and verification functions, while keeping misreads to a minimum.

The term “inspection” covers a range of applications, but it is just a testament to the versatility of machine vision.

Products can be inspected to make sure they have been assembled correctly, are the correct color, or have the correct surface texture.

Serving as the eyes, machine vision products can guide robotic arms.

Integrating these two technologies — machine vision and robotics — continues to propel manufacturing automation forward. This combination can be used for tasks like matching and sorting items on a production line.

Measure with machine vision

The system is able to determine various measurements of an item based on changes in pixel intensity, like the fill level of liquids in a bottle or the angle of the tip of a needle.
Advantages of machine vision

Machine vision systems can be used to combat some of your biggest production and quality challenges.

- **Increase production throughput**
  Eliminating the human element during inspection reduces downtime and increases throughput. Machine vision systems can be setup to run non-stop and aren’t constrained to human limitations.

- **Consistency and precision**
  Adding a non-subjective inspection element ensures that different facilities inspect with the same standards and produce results that are consistent.

- **Reduced waste and costs**
  Machine vision systems enable lean manufacturing, giving you the ability to identify defects before more value is added. They also reduce costs associated with recall and product replacement, since you are able to identify and prevent defective parts before they leave the plant floor.

- **Advanced Monitoring and Predictive Maintenance**
  Systems can be remotely monitored, allowing for advanced diagnostics and troubleshooting. The ability to constantly monitor performance leads to identifying issues sooner, which can prevent downtime and lower service costs.

- **Lower cost of labor**
  While there will be a large initial investment, the system will not incur ongoing costs associated with payroll, benefits, training and human liability.

- **Improved safety**
  Replacing in-process human inspection with machine vision systems can help remove human inspectors from the production floor — enabling huge safety benefits.

- **Multi-dimensional**
  The multi-dimensional software enables the system to perform different tasks. Systems are flexible and can be programmed with different algorithms to perform different tasks, like counting pixels, identifying edges, finding patterns, and measuring components.

- **Easy data collection**
  Machine vision systems also create opportunities to collect data that can be used for immediate analysis or archived for future use in planning, tracking, and improving production.
PLANNING YOUR MACHINE VISION PROJECT

3 considerations for defining project scope

Improvements to productivity and quality are achievable with machine vision systems, but challenges to successfully implementing a project are inevitable. The details of a project’s scope is one challenge we often need to address with clients. It’s easy to identify high-level goals and deliverables of a machine vision project, but pinpointing specifics early in the project will help you stay on track.

1. Define your problem and your budget
Create a shared understanding with your integrator by determining what needs to be fixed or improved and how much your company is willing to spend. This will give the integrator a better understanding of how they can help you. Outlining what you are trying to measure and accomplish ensures that you are spending your time and money developing a solution that can solve your problem.

2. Survey your existing environment
You will need to audit your existing equipment and operating environment so the integrator can determine what will and won’t work within your process. They will need to know things like the speed of production and age of your equipment before they can offer a viable solution.

3. Identify the stakeholders
Formalizing roles and assigning areas of responsibility will help you deliver your project successfully and on time. With a project team in place and the correct stakeholders involved, you can avoid making assumptions about the project. Assumptions can lead to confusion, scope creep, or project derailment.

Budget Criteria:
- Can you describe the application or inspection to be performed?
- What is the cause of our problem?
- What is the timing (in terms of installation and fiscal year) and budget of the project?

Survey Criteria:
- How old is our existing equipment and will any of it be upgraded in the near future?
- Is this to retrofit an existing inspection solution?
- Is there anything to note about the temperature, lighting, or environment of the inspection area?

Stakeholder Criteria:
- Who has the technical knowledge, managerial skills, and time to drive the project?
- Who will have the ultimate say in making business, financial, and technical decisions?
- What objectives and responsibilities will each person have?
PLANNING YOUR MACHINE VISION PROJECT

Justify the Return on Investment

Operations managers and technical engineers might consider a new technology an obvious and worthwhile investment. But explaining the benefits and value to a financial review board can be a tricky task. Here are some strategies on how to justify your investment in machine vision.

Find an ally in the finance department.

Enlisting someone from the finance or accounting team can be helpful as you work through the costs of your potential machine vision project. This partner will not only speak the finance language, but they will also have a better understanding of how to analyze the project’s benefits and translate them to show positive financial results.

Consider lifetime costs.

Take into account the costs associated with running, maintaining, and improving your vision system. Determine whether or not your company will need to make adjustments to the existing operating environment to accommodate the new machine vision system. Evaluate how easy it will be to adjust in the future for further updates or enhancements. Software licenses and ongoing training are also lifetime costs to consider.

Focus on capital ROI.

Instead of thinking in terms of how production will get better, faster, and more efficient, consider how the results of these process improvements can reduce costs and improve the bottom line. For example, identifying defects before they leave the plant floor can eliminate costs associated with recalling and replacing a product. A machine vision system that reduces the rate of worker accidents can impact insurance premiums.

Ensure overall business alignment.

Making sure your new machine vision system aligns with overall business strategies can be important. If your company is focused on environmental sustainability, detail how that the project will help the company achieve green manufacturing goals. If your company is focused on maintaining current headcount, make sure to communicate that the machine vision system can scale production without additional human support.
Choosing the right camera

In the process of planning your machine vision project, you should have confirmed what your current needs are and the type of product you’ll need to have imaged. Your scope, budget, and process limitations are the factors that will determine what type of camera is the best for you.

There are a few aspects to consider that will guide your camera decision:

1. What is the size of the part being considered?
2. How quickly will the part be moving?
3. How close can the camera get to the object?

Resolution

The light received by the camera will be projected onto a grid called a sensor. Its size is referred to as the camera’s resolution. There are a number of light-capturing objects on the sensor called pixels, and the camera’s resolution gives an indication of how many pixels the sensor has. Higher resolution sensors allow smaller features of an object to be distinguished. Determining deviations on small part production or reading data matrix barcodes may require a higher resolution camera. However, the need for higher resolution may be mitigated if your production environment allows the camera to come close to the object in question.

Frame Rate

If your vision system is taking a finite amount of images of your products, it’s important to consider the frame rate of your camera. This is rate at which your camera is able to take stills of your part or object. It’s important that your camera has a frame rate that can keep up with your production speed.

Additionally, choosing a camera that allows you to adjust shutter speed will help you ensure that none of your parts, objects or labels are being captured in blurry images.
Choosing the right lighting component

An essential step to ensure precise images of the products being checked/produced is guaranteeing that your camera can produce/view them in the most ideal environment.

To produce the best images that will contribute to improving your process, it’s key to capture an image that will maximize contrast on the part or object or label, and minimize contrast with that object’s surrounding. There are a few questions to ask yourself that can help guide your decisions:

1. What effect does the ambient light of your production environment have?
2. How do the light levels change throughout the day?
3. How will part variations affect your image (i.e. orientation)?

Light Source

Depending on the use case, camera, and operating environment, different types of lights are needed to produce an ideal image. The light source will determine how bright your object can be; this may help overcome some of the camera’s limitations.

Your budget will help determine which types of light can be implemented in your vision process. The expected life of bulbs and electricity output are additional costs to consider when selecting a light source. Additionally, it’s important to consider how your lighting’s heat output affects your parts and production space. Different light sources also emit different intensities along the visible (and invisible) light spectrum and some may be better suited than others to block out ambient light and errant reflected light.
Keys to post-installation success

While machine vision systems are reliable solutions to quality assurance, regular maintenance is an integral part of making sure that your cameras continue to operate efficiently and capture quality images.

One benefit of the aluminum framing used to mount a machine vision system is that it lacks moving parts. The system itself will not wear down over time and doesn’t call for regular part replacement. However, this means that any problems coming from your equipment are bound to have an immediate impact. Unexpected issues might include the loss of an image because of disconnected cabling, or simply because the camera was knocked out of place. Problems like these can be managed by having better strategic camera placement.

Maintaining your vision system doesn’t stop with correcting sudden issues. The lighting and production environment play a big part in detracting from the quality of your images.

Monitoring and diagnosing your machine vision systems

Lighting

Lighting is one of the smaller costs of machine vision, but, if not monitored, can cause unexpected costs in the form of falsely rejected parts and externalities of missing defects.

Depending on the type, your light source is bound to become dim over time. This is especially true of incandescent light. Losing the light’s intensity will negatively impact the contrast you’re trying to achieve in your image. It’s also likely that your lighting arrangement will also have to change if your part changes.

The environmental lighting that you adjusted when setting up your vision system will also change over time. If your production environment is heavily window-lit, the change in season will have an impact. You will also need to consider the lighting environment if the plant is running multiple shifts and when Daylight Savings Time occurs.

Production Environment

The production environment can have just as strong of an impact as the lighting environment. A camera’s surroundings have an impact on how well it performs. Vibration has the potential to create blur in an image by making the camera shutter. Cameras are securely mounted using extruded aluminum framing. This type of framing provides a stable base for the camera and is an easy way to retrofit it into your existing assembly.

Depending on your environment, your personnel may wear glasses to protect themselves from debris and particles in the air. The camera lens is subject to the same debris. Having dirt in the lens will ruin the image, so if it’s not possible to clean your cameras, the next best precaution is to give them some enclosure.
Achieving machine vision

Increase throughput and savings with advanced machine vision systems. Take the first step to improving any manufacturing process by requesting a machine vision consultation with Automation Technology.

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