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TECHNOLOGICAL SOLUTIONS



GUIDELINES FOR CHOOSING AND IMPLEMENTING **A MACHINE VISION SYSTEM**

WHAT YOU NEED TO KNOW
TO ENSURE SUCCESS



overview

The key objective is to minimize the amount of trial and errors and to choose a machine vision system able to serve your current, and future, company needs as smoothly as possible.



Nowadays, machine vision is used to ensure the quality of many products, regardless of their size or shape.

In the latest years **this technology has evolved in such a way** (more functionality, ease of use, lower prices and increased availability of providers) that **it has become a vital automation component** that enables systems to **replace human vision** in many **high-precision and high speed processes in a more reliable efficient and economical way**.

While those technological developments are an advantage (that encouraged more and more companies to adopt machine vision), **they also hinder the right choice**. Therefore it is essential to conduct a thorough evaluation before investing in a specific system.

Moreover, those who have been faced with choosing and/or carrying out a machine vision system know how challenging it is to select a solution that is at the same time economical and efficient because it depends on multiple factors such as:

- Equipment selection and development based on the requirements of each situation
- Development timings
- Installation and integration with other systems
- User interface
- Maintenance and updates

Machine vision systems allow 100% product inspection, and ensure defect free products out of the production line.

The main goal of this document **is to present useful information that simplifies the selection process** of your next (or update existing) **machine vision system and minimize the amount of trial and costly errors that can be fatal**.

The aim is to make the selected system able to serve the current needs of your company and to adapt in the most economical, efficient and smooth way as possible to the trends, changes and demands, whether internal or from the market.

Nowadays business reputation is more important than ever. Many companies refuse to do business with any supplier whose quality has been questioned. Machine vision systems are a required tool to ensure the quality of your products, and provide the evidence and traceability of such quality.



WHY SO MANY MACHINE VISION SYSTEMS FAIL

Machine vision is a highly specialized technology and its success depends on many factors, such as:

- **Highly detailed knowledge of the most suitable equipment for each situation** (cameras, optics, lighting, processors, networks, software)
- **Production line conditions**, e.g. environmental lighting conditions
- Proper **definition of goals and application requirements**
- Proper integration and interface with multiple systems and subsystems
- **Project team selection**
- Reliable and consistent inspection of all components, **without compromising the maximum production line throughput, nor increasing the number of false rejections**
- Proper definition of all tests
- **User friendly interface**
- Who will **manage the system**, and how it should be managed
- Who needs training, what kind of **training** and how to train
- Who will carry out **maintenance and support**

Usually, the cost of a proper built machine vision system is smaller than the cost of a misconceived one.



No business can depend on a machine vision system that:

- **Inhibits replacement** of any **production line equipment**
- Limits the interface with new equipment
- **Disables the evolution of its specific tasks**, either applied to the same products or to new products
- Has a complex configuration
- **Induces long stoppages on the production lines** while changes are being made.

The high risk, introduced by machine vision systems, associated with those previous factors, may block the decision to implement any solution at all.



HOW MUCH DOES IT COST NOT TO IMPLEMENT ANY SOLUTION?

In fact, quality control has always been there, usually done by sampling. **Nowadays technology allows quality control at the piece level, which raises the process control standards and traceability.** If we add to that the capacity to build an integrated information infrastructure, from the production line up to the decision level, then we will have a high quality control solution with real added value.

THESE ARE SOME OF CHALLENGES AND DEMANDS FROM THE CURRENT MARKET:

- ↘ Increased competitive environment (additional low-cost, along with global, suppliers)
- ↘ Limited access to investment
- ↘ Shorter product life cycle
- ↘ Increased demand for customized products
- ↘ New prospects from emerging markets

THOSE ARE CRUCIAL TESTS FOR THE ORGANIZATION'S CAPABILITY TO RE-INVENT ITSELF.

The decision not to implement a machine vision solution can represent, in practice:

- ↘ **Lower quality products compared with competition** (due to lower quality control)
- ↘ **Decreased traceability on the production lines**, which will cause:
 - **Loss of production process visibility**, essential for proactive error correction and continuous improvement (timely error feedback as well their causes allows immediate correction)
 - **Loss of opportunity to certify product quality as they leave the production line** (in case of complaints)
- ↘ **Disadvantage regarding competition** that has machine vision systems and can guarantee superior quality levels of products and services
- ↘ **Bigger environmental impact costs**, resulting from an excessive production of defective material (caused by the absence, or inadequacy, of a good quality control) and its consequent destruction

In the following sections we will present the critical elements that guarantee the success of any machine vision system in order to avoid any errors that may cause its complete failure.

Some of the subjects that we will cover in this document, such as image processing, software and camera selection, etc., could be further developed and would extend the scope of this document. Our goal is to provide a useful guide to ensure the success of your machine vision systems with minimum risks and costs and maximum efficiency and effectiveness.

2 CRITICAL FACTORS THAT GUARANTEE THE SUCCESS OF ANY MACHINE VISION SYSTEM

One way to maximize the success of any artificial vision system is to develop the project in three phases:

1. Definition of goals and application requirements
2. Solution design and development
3. Solution integration and testing

Since the “Definition of Goals and Application Requirements” is crucial for the success of any artificial vision solution, we will develop it further on the following sections.

DEFINITION OF GOALS AND APPLICATION REQUIREMENTS

The first step is to define the physical and operational requirements and goals of the machine vision project. Starting by obtaining the answers for the following critical questions:

Which are the functional specifications and tasks?

Different tasks require distinct vision attributes. It's necessary to specify in detail the physical measurements and relevant settings for each application, product, process and components involved.

For instance, inspection requires the ability to examine objects in detail and evaluate the acquired images to make pass/fail decisions. Assembly requires the ability to scan an image to locate reference marks and then use those marks to determine placement and orientation of parts.

Which are the possible upgrades of the solution?

The requirement's survey should take into account the possible upgrades of the solution, both in the short and medium term.

Even if those requirements are not immediately needed, it is important to consider and analyze them. Failure to do

so may limit the evolution/scalability of the solution. The evolution potential gained justifies any eventual increase in the initial investment.



“Today, changes in society have a deeper impact on companies than changes in management.”

Peter F. Drucker

Which are the key performance criteria?

Factors such as the smallest object or defect to be detected (tolerances), the image size (field of view), speed of image capture and processing, or the need for color all influence lighting, camera and lens choices.

Which are the environmental factors?

Certain equipment (lighting, cameras, optics) are more suitable to capture stationary views while others are better for handling linear object motion.

Proper choice of lighting is a crucial factor in the success of any vision solution. In addition the environmental



conditions (humidity, temperature, vibration levels of toxicity) where the system will be installed may restrict equipment choice.

Which equipment must the vision system interface with?

A vision system which carries out the supervision of a production line is necessarily simpler than one that includes the traceability of the production process and communication with the information system and/or performs some kind of production line control based on inspection results.

Which information must the system provide?

Vision systems seldom operate in a stand-alone mode. Instead they must collect and send information to other systems. For instance, quality traceability requires logging and/or reporting inspection results as well as report creation to support production management.

Which are the operator requirements?

It's important to determine if operators are required to change periodically inspection criteria, such as the accepted tolerance levels as well as input validation to avoid erroneous configuration settings that can compromise the production.

It is also important to determine the need to provide security to prevent unauthorized access to configuration settings.

Therefore the user interface must be as simple and intuitive as possible, be tailored to the requirements of each production process and include complete support documentation.

Solution that works versus functional solution

There is a big difference between a solution that works and a functional solution. A solution that works is not necessarily a functional solution.

For instance, the choice of components, their location and distribution on the production line, and the user interface are crucial to determine if a solution that works is in fact a functional solution.

If the error correction procedures in a solution that works are too complex and time consuming then the solution is not functional – it compromises the production line productivity. The wrong components or the right components at the wrong location, can compromise all the production line.

Who will program, implement, configure and maintain the system?

As mentioned in "Why So Many Machine Vision Systems Fail?", your company cannot depend on a machine vision system that cannot adapt to evolving tasks. For instance, if the system needs to evolve, either to inspect a new product or communicate with a new production line, who will program those updates?

Therefore it is essential to determine the selection, development, deployment, configuration and maintenance processes of any machine vision system, either for an "off-the-shelf" solution or for a custom made solution. We will discuss that in the next sections.

3

GUIDELINES FOR SELECTING, DEVELOPING AND IMPLEMENTING A MACHINE VISION SYSTEM

CHOOSE AN "OFF-THE-SHELF" SOLUTION

Some manufacturers supply machine vision solutions that include detection methods and algorithms integrated into the programming as well as reporting tools.

These types of solutions are developed to address certain needs but may not be the best option to meet all the requirements and needs (see section "Defining the Goals and application Requirements).

A system developed with enough flexibility to allow custom configuration and scalability may cost more initially, but will save production time and avoid a lot of future problems.

The main issue around these kinds of solutions is that **they do not have enough flexibility to allow the evolution of the system** (either new requirements, or scalability of the solution itself), such as the addition of new cameras (see section "Developing and Implementing an In-House Solution"), since the challenges of these overlap with those of the "off-the-shelf" solutions.

DEVELOPING AND IMPLEMENTING AN IN-HOUSE SOLUTION

If your company has a team of engineers with experience in machine vision systems, and enough knowledge to choose the equipment according to the application requirements, you may choose to develop, install and configure the solution internally.

At first sight the total cost of this option may seem lower. However, **it is necessary to take into account research development costs, thorough testing and installation.**



Consider also the **internal team training skills** (most often limited), which also contributes for the overall costs.

Besides do not forget that machine vision technology and equipment are constantly and rapidly evolving. **The internal team must have the capacity to identify and integrate the appropriate technologies and equipment, from within a wide range of available options** so that the system needs to be able to:

- Collect and analyze images based on the key features of each product
- Allow the inspection of all units reliably and consistently without compromising maximum performance of the production line and without increasing the number of false rejections

Another important factor to consider is the fact that even though **the internal team** may have enough experience in development and integration of one or more projects, they will never have **the level of experience of a specialized supplier / integrator that has already developed and integrated many projects.**

CHOOSING A SUPPLIER

First of all let's define the concept of supplier in the context of this document starting by considering the following categories:

Retail/Reseller Element of the distribution channel responsible for reselling products acquired from manufacturers, to the end user without added value.

Integrator/VAR Company that sells products/services, as well as solutions to end users. Usually a solution is the assembly of hardware, software and services with added value.

In this document we will consider suppliers as the machine vision integrator/VAR that typically buy the adequate equipment from one or more manufacturers and are expert in application development, installation and maintenance of machine vision technologies.

The category of integrators/VAR can be broken into:

Experts in a single machine vision equipment and technology platform, whether or not they work for the manufacturers of that platform.

The advantage is that these experts are usually **very good with certain applications and certain technologies**.

The disadvantage is that they will **exclusively use their equipment and technologies** to address any problem/requirement.

Experts in multiple machine vision equipment and technology platforms. They do not work for any manufacturing company.

The advantage is that since they **have the knowledge and experience in a wider range of technologies and applications**, they can apply those most suited for each problem/requirements.

The disadvantage is that they **may not have such a deep knowledge of a particular technology/application**.

However, nothing prevents them from looking for direct support from the experts in that technology/application, and that disadvantage disappears.

WHICH ARE THE ADVANTAGES OF WORKING WITH A MACHINE VISION SUPPLIER?

- Deep knowledge of key technologies and experience in various industries
- Objective perspective of the customer's situation
- Ability to assess requirements and provide the appropriate functional specification
- Ability to develop a solution using the most suitable technology
- Ability to avoid unnecessary and costly errors
- Possibility of saving time and money
- Providing adequate training



4 HOW TO SELECT THE RIGHT MACHINE VISION SUPPLIER?

In the process of selecting the right supplier that contributes for the success of your machine vision systems, make sure he has proven knowledge and experience about everything covered in “Defining the Goals and Application Requirements”. Additionally you should guarantee they have the following features:

Wide experience in real environments and independence from manufacturers

The first important step is to find a **machine vision supplier with a solid system implementation experience in real environments.**

The ideal supplier **should not be tied to one or several machine vision technology manufacturers.** This **avoids falling into a proposed solution that fits the technologies available from their exclusive or preferred machine vision source instead of helping to assess the specific needs of each situation and determine the appropriate components and most suitable systems.**



For instance, select the supplier capable to recommend the platform of computers, operational systems, software and cameras most suited to the goals and the application requirements. Preferably, that supplier should provide useful and relevant information (white papers, case studies, articles and other presentations) that simultaneously support their knowledge and experience.

USEFUL TIP

To ensure that the supplier has the knowledge and experience in a wide range of applications and situations, ask for:

- A list of developed and installed systems, from three or more different machine vision technologies and suppliers.
- A client list that you should be able to establish contact with (it is natural that these are happy customers, since the supplier will hardly refer any dissatisfied client)

Ability to reuse and/or adapt existing systems

The supplier must be able to analyze already deployed solutions and, if possible, reuse and/or adapt them. That can reduce the costs of the new solution.

Software development know-how

The ideal supplier should have the capability to develop software, not only to fulfill the specific requirements of the system but also to interface with other equipment and users.

USEFUL TIP

The supplier should have machine vision programming and operational skills as well as control and robotics programming skills (at least at the level of the communication debug).

That knowledge is useful throughout the installation and simplifies troubleshooting. Will also avoid many “headaches” and project cost overruns.

Support, maintenance and training services

Make sure the supplier is able to provide a fast and effective support service. It is also important that the supplier is able to carry out adequate training to each user profile as well as to create and supply specific user manuals (in addition to the equipment manufacturer’s manuals).

USEFULL TIP

Make sure the supplier can provide local and/or remote support. Local support is not always provided by the supplier. Sometimes uses local partners and/or remote support. If local support is needed, ask about the traveling costs. Remember that the geographic distance between you and the chosen supplier should never be a barrier.

For those who do not have experience in machine vision systems, besides the above-mentioned characteristics, **the long term relationship with the supplier should also be considered. It has a direct impact not only in the machine vision system to develop, install and maintain, but also in the company’s future.**

Many suppliers over promise what they can deliver, but only few can provide a system, minimally functional and scalable, able to meet the specific requirements of each case.

conclusion

When the proper machine vision system is built and supported correctly, it is a fundamental tool to create more efficient and profitable production and management processes.



Machine vision systems require thoughtful planning and analysis

A machine vision system implementation is not a decision to be taken lightly.

For a wide range of businesses the key to a successful machine vision project lies on the selection of a specialized supplier that puts customer needs first and possesses the knowledge, experience and characteristics presented in this document.

The right supplier should be able to guide you through the whole process (here, complexity can be overwhelming) because he has the experience and knowledge to prevent you from making the wrong choices. Also notice that the supplier should play a partner role in the whole process, and not be just a supplier.

about us



TST IS A TECHNOLOGICAL COMPANY SPECIALIZED IN MACHINE VISION SYSTEMS.

Operating for more than 15 years in the Portuguese and international markets, we are **specialists in the design, development, deployment and marketing of supervision systems, control systems and traceability for industrial processes.**

Our structure, based on high skill specialized engineering, allows us to supply a **variety of technological solutions, highly flexible and personalized to meet the specific requirements of our customers.**

Our services include:

- ↳ Engineering and consulting
- ↳ Project management
- ↳ Database design and integration
- ↳ Quality control
- ↳ Automation
- ↳ Interface design
- ↳ Application design and programming

Our solutions are based on standard components that can be easily replaced and/or updated ("off-the-shelf"), such as computer components.

We advise on the vision components that meet the specific requirements of each situation. We are not bound to an exclusive or preferred machine vision source manufacturer. Naturally, in order to reuse some solutions and/or components we look for continuity; however that does not mean we are limited, conditioned and/or have to adapt to what already exists. In fact we already created hardware solutions from scratch due to the lack of available hardware solutions in the market. The feedback of our customers is essential for the success and progress of all our solutions, including reported errors, enhancements, new features, documentation, etc.

We provide local, telephone and remote support to our machine vision systems.

All our solutions have real-time logging capability. This means that their activity can be emailed to our technical team, or remotely supported by our technicians to identify, solve and improve each solution. That is why we have always invested a lot in remote support tailored to each customer.

Our solutions are targeted for a variety of industry segments, such as:

- ↘ Print and finishing
- ↘ Graphics
- ↘ Packaging
- ↘ Component inspection
- ↘ Automotive
- ↘ Food and beverage
- ↘ Pharmaceutical

MORE INFORMATION

To find how our solutions can help you deliver the right product, at the right time with the lowest cost and at same time ensure the success of your machine vision systems,

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