What is machine vision

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Difficulté **Difficile** | Durée **60 minute(s)** | Catégories **Électronique** | Coût **0 USD ($)**

Sommaire

Introduction

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Machine vision technology allows industrial equipment to "see" and interact with objects, which in turn helps to improve the quality of manufactured products, reduce production costs, and simplify tasks.

Benefits of Machine Vision

Machine vision improves company efficiency, productivity and saves money. The introduction of machine vision systems in production significantly increases its competitiveness, which is due to a number of obvious advantages of robotic labor:

1. Computer vision is ideal for routine, repetitive tasks where a person can easily lose focus and make mistakes;
2. In areas that require high precision, such as pharmaceuticals and mechanical engineering, machine vision guarantees the absolute accuracy of tasks;
3. A significant advantage of machine vision over human labor is the ability of a computer to detect millions of shades and gradations of colors in images that are inaccessible to the human eye;
4. Machine vision is able to simultaneously perceive a huge variety of objects, which not only reduces the time to complete tasks, but also expands the functionality of the possibilities.

Machine vision tasks

Typical tasks that are solved using machine vision systems:

1. compliance with product quality;
2. detection and search of objects, measurement of sizes;
3. tool management (machine, robot, etc.);
4. testing and calibration;
5. management of production processes in real time;
6. collection, recognition and identification of information, comparison with a given template;

7. equipment monitoring;
8. image recovery;
9. barcode reading;
10. sorting/counting objects;
11. Color analysis.

Before turning to practical examples, let's define the most important components. Typically, vision systems are divided into two independent subsystems:

1. Acquisition of images;
2. Image processing.

Each of them, in turn, includes a different set of components depending on the requirements of a particular application.

Components of a machine vision system

With image processing, everything is more or less clear:

1. calculator (one or another processor, graphics coprocessor, DSP or FPGA);
2. mathematical algorithms that work on this calculator.

In practice, certain platforms and software are used “as is”, and rarely anything changes in the algorithms themselves. The task of the developer is to choose the types of algorithms and their sequence. And here a tool that allows you to easily and conveniently operate with images becomes of great importance.

And here the most important thing begins. But for this they (images) must first be obtained. An image, an array of pixel values, or a cloud of points, in the case of multidimensional representations, can be obtained in various ways, and the developer plays a decisive role in this:

1. video camera;
2. thermal imaging camera;
3. laser 3D scanner;
4. TOF camera;
5. and many others.

And in each case, the choice is not limited to one type of device. A video camera can be a matrix camera, or it can be linear, color or monochrome, with different resolutions and matrix sizes. Sometimes you have to sacrifice resolution in favor of pixel size, and sometimes a small pixel is preferable (for observing small objects). Depending on the type of camera and the object being examined, you may also need:

1. Input-output equipment;
2. Lighting system;
3. Camera lenses.

It is equally useless to use a good, expensive camera with a mediocre, cheap lens, and vice versa. The lens can be ordinary, or it can be telecentric or special for "peeping" into the pipe or, conversely, coverage of 360 °. The light can be shadow, direct, angled, coaxial, white or monochromatic, pulsed or structured. Of course, various combinations of all of the above options are possible.

Selection of machine vision components

The choice of the wrong technical solution for obtaining an image is very difficult to compensate with the most complex mathematical algorithms. Unfortunately, our own experience plays an important role in making a mistake: it is not difficult for a person to receive (see) and process a picture without all these "wisdom". This happens, as it seems to us, instantly and requires much less effort than solving a quadratic equation, with which the computer copes faster than us. From which we draw a simple but incorrect conclusion: obtaining and processing images for a computer is not a very difficult task, because it is so “smart”. But that's not the case at all. Despite the obvious progress in computing power, digital cameras and algorithms, modern machine vision systems are not able to “easily” solve tasks that seem trifling to a person.

We tend to underestimate the capabilities of our brain and vision. This is the source of a number of failures and disappointments from attempts to use machine vision systems in industrial applications. Equipment manufacturers often fail to draw the attention of their consumers to the fact that even the most advanced camera with the latest software is a necessary but not sufficient component of success. A perfect camera has not made anyone a professional photographer overnight. Despite a number of "helpers" (auto exposure, auto focus), knowledge and considerable experience are needed to choose the time and point of shooting, lighting, aperture and focus point to get a good picture. In this case, as a rule, the goal is not to obtain a repeatable picture of an object with detail, regardless of its color, external illumination or rotation, to avoid shadows, uneven lighting, hide or emphasize defects in shape or surface - i.e. facilitate subsequent processing as much as possible, increase the reliability and reliability of the algorithms. But these are only a small fraction of the issues without which the operation of machine vision systems will not be effective.

From the foregoing, a disappointing conclusion follows: for all the seeming triviality of the task of visual control, the construction of a working machine vision system requires the involvement of professionals at the earliest stages, from the selection of equipment to its installation, training of algorithms and subsequent maintenance. Do not trust sellers who convince you that this "wonder camera" will solve all your problems. Practical experience and knowledge gained in the creation of vision systems that work in production are important as in no other applied engineering field due to the initial high degree of uncertainty of the conditions and the object of study. Corresponding to this (literally and figuratively) is the value of both engineers and companies with such experience. Is this not a reason for young professionals to think about the area of application of their efforts?

Application of machine vision: examples

Even in seemingly simple issues of visual control of juice jars on a conveyor or medicine ampoules, a number of issues may arise that require a systematic approach and certain experience. For example, it is genuinely surprising that the control of an excise stamp glued vertically and horizontally on a round bottle requires different technical solutions. For a more detailed illustration, let's consider the problem a little more complicated. For example, the integration of technical vision into the system of electrical testing of film capacitors in their mass production. The test subject is selected from our practice, but can be easily replaced with smaller or larger items from any production area, be it the food industry or the automotive industry. So,

1. Visual control of the surface, shape;
2. Control of machines and feed mechanisms, in this project these are industrial robots;
3. Accounting (identification, sorting, marking, etc.)

In the example under consideration, capacitors are rectangular objects with face sizes from 3 to 20 mm of two types: output - and a surface-mounted version, i.e. without legs - conclusions. The hatcher, in turn, is divided into two types of body: in fact, corpus and pupated. The corpus one has strictly orthogonal parallelepiped shapes, the pupated one has a certain rounded shape, similar to a rectangular lollipop with oval edges. All of them differ in the size of the case, its color, and the output ones also differ in diameter, length of the outputs and the distance between them. In addition, the conclusions can be located on different sides or on one side.

The supply of capacitors for testing is carried out in bulk, i.e. bunch out of the box. The list of object manipulations looks like this:

1. Take an object from the "heap";
2. Check its type (in form and marking);
3. Assess the condition of the case for visible damage, scratches, chips;
4. Move to electrical testing station;
5. Carry out electrical tests;
6. Move from the electrical test station to the appropriate tray depending on the test result (Rejection and sorting by rating).

The installation should work with all types of capacitors without significant readjustment, and preferably without it at all. Let's consider the most complex variant with pupated capacitors (that is, having a body shape other than rectangular in two sections).

To capture the capacitor from the “heap”, a picture is used from a camera located above the “luminous” section of the vibrating table that feeds. The algorithm selects a “free” capacitor in the image and passes its coordinates to a robot equipped with a pneumatic suction cup for capture. In the absence of a free capacitor, a “shake” command is sent to the feed table controller, after which a new picture is analyzed. The procedure is repeated until the object to be captured appears in the field of view.

The robot moves the captured object to the first control zone, where, in addition to evaluating the shape of the body, length and location of the leads, its compliance with the type specified by the program is determined.

Pneumatic grip allows you to manipulate objects of different shapes and sizes, but this results in a large spread in the actual position of the product in the grip. In addition, the terminals of the capacitor can be shifted in one direction or another. To determine the positioning error, a machine vision system is used that evaluates the actual position of the product in the grip in the coordinates of the robot. To estimate displacements in the third dimension, the triangulation principle is used with additional laser illumination. Thus, in the next operation, the required accuracy of element placement in the mechanical grip is achieved. In some cases, a decision is made that it is impossible to manipulate this sample, and it is sent to marriage or to a container for "manual" processing.

A mechanical gripper with a pneumatic drive aligns the leads for subsequent placement of the device in the connector of the electrical testing station and transfers the product for subsequent manipulations to the second robot.

Identical bolts are located at different distances from the camera. The detail on the left is a cylinder extended along the axis of the lens.

To increase the reliability of the control of a rounded case, telecentric lenses are used, which allow not only to more accurately estimate the geometric dimensions, but also to increase the depth of field of the image, which makes it possible to work with objects of different sizes.

To obtain certain characteristics, various types of LED illumination are used: background, diffuse direct light, laser triangulation.

The motion system works in close cooperation with the test station and machine vision subsystems. The electrical testing process is the longest stage - therefore, in order to increase the productivity of the installation, it is important that only products that successfully pass all other tests arrive here. At all stages of control, rejection of the product is provided.

Depending on the test results, capacitors can be sorted by rating or other performance characteristics.

The choice of equipment and tools for the development of machine vision systems

The installation consists of several subsystems from different manufacturers:

1. Feeder, vibrating table Anyfeed (Switzerland), controlled via serial link;
2. Image capture systems are equipped with ace digital cameras (Basler AG, Germany) with different lenses depending on the selected resolution and subject. An Ethernet interface with built-in power circuits (PoE) provides the required flexibility - cameras are connected via a single cable using a network hub;
3. Telecentric lenses (DZOptics, China) are used at several control posts, in other cases - ordinary lenses of the middle price range;
4. General synchronization and control of mechanisms and robots is carried out using a set of discrete sensors and an industrial controller cRIO (National Instruments Corp., USA);
5. The electrical testing station was built on the basis of the PXI industrial measuring platform and modular instruments from National Instruments Corp., USA.

A single tool for developing machine vision systems allows not only to reduce the cost of creation (one team of developers works or several - they “speak” the same language), but also significantly increases the reliability of the application software, since it does not require the integration of several different programs, developed in different languages.

Machine Vision Development: Conclusions

The successful development and implementation of machine vision in the production process is a rather complex engineering task, despite its apparent simplicity. But this should not become an obstacle to the development of modern technologies, because. The relevance of machine vision is growing rapidly.

If you decide to build a vision system yourself, then be prepared for the fact that success will not come immediately. It is generally an iterative process consisting of numerous experiments with cameras, lights, and image processing algorithms. There are a large number of development tools on the market that allow you to solve typical problems without programming, but they all take time to master. In addition, each object of study needs its own, individual approach to finding the optimal technical solution.

The easiest way to reduce the number of problems at the initial stage is to describe your task to the supplier of the components of the future system. Professional advice will help you avoid obvious mistakes. If you are offered a “wonder camera” that easily solves any problem, ask to demonstrate it on your sample and make sure that it is really “easy and simple”. If you are not confident in your abilities or if you have more important things to do, entrust the solution to people who have practical experience in working with vision systems and their integration into machines and production processes.

1.

Matériaux

Outils

Étape 1 -