Acquisition Practical

Labs 4 - Compact Vision System

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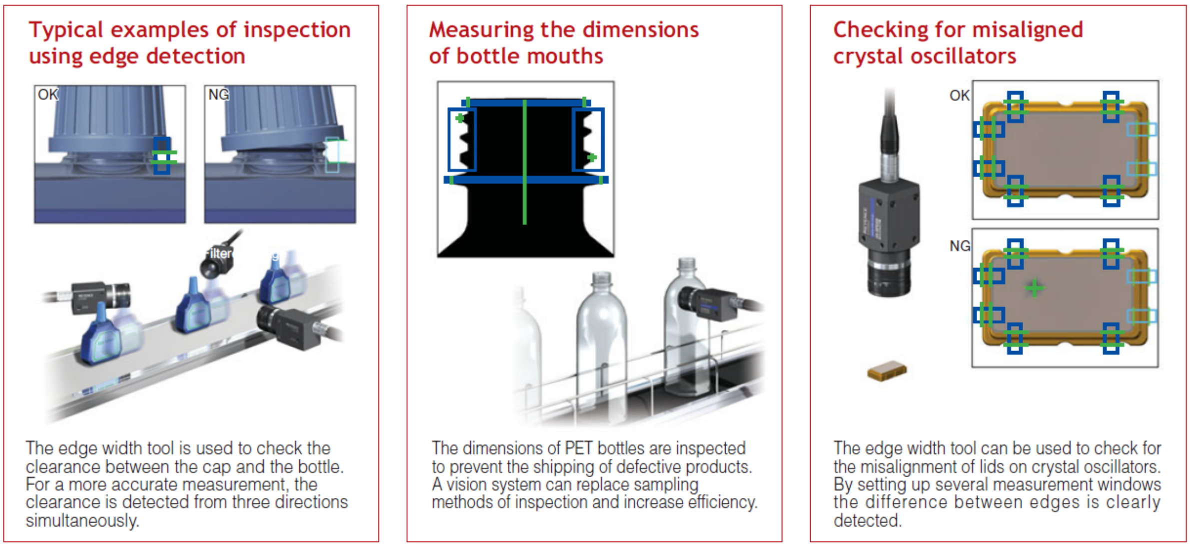
Introduction

Compact Vision Systems are hardened automation controllers that combine connectivity to industrial cameras, open communications, and FPGA-based I / O in a compact form factor. They are designed for real-time image acquisition and processing from multiple cameras and provide the flexibility, integration, and robustness needed for many industrial inspection, alignment.

A smart camera is a vision system which, in addition to image capture circuitry, is capable of extracting application-specific information from the captured image, along with generating event descriptions or making decisions that are used in an intelligent and automated system. Using edge detection for dimensional inspections has become a recent trend in image sensor applications. Edge tools provide a simple yet stable method for detecting part position, width, and angle. Here is some typical examples of inspection using edge detection:



Objectives

The goal of this lab is to educate ourself about the Compact Vision System from KEYENCE and program it.We will see how camera system operates and how to program the KEYENCE system to obtain satisfactory result. We will be using a smart camera with embeded system software. We will finish by giving our own conclusion about compact vision system.

Chapter 1

Study of the system

1.1 Installation

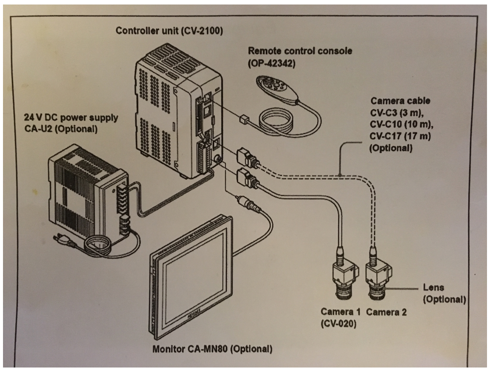


Figure 1.1: Datasheet of the installation

1.2 User Manual

1.2.1 Basic Operation

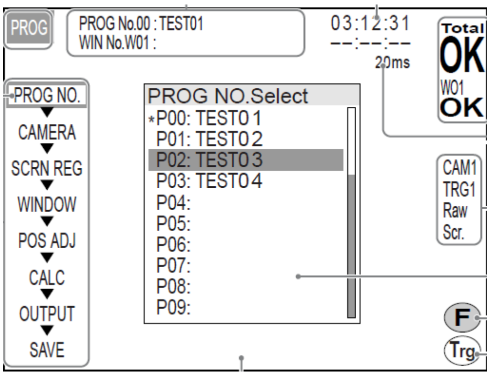


Figure 1.2: Layout of the screen

This shows the screen layout as it is:

1. Program number : will display the name of the program choosen
2. Camera image : display the image that is input from the camera
3. Trg: which correspond to the trigger

Others functionalities have been given in more details in the user manual.

Chapter 2

Pattern detection

2.1 Edge detection

In this part our task was to program edege detection in order to characterize the holder width on the industrial part. We will use "Edge Pitch" Measurement Mode program to estimate the width of the holders.

2.1.1 Definition

An edge is a border that separates a bright area from a dark area within an image. To detect an edge this border of different shades must be processed. Within a specified measurement area, multiple edges can be detected in a selected direction.

2.1.2 Choosing a tool

For the edge detection, we used an integrated instrument, called "Edge Pitch". By using this instrument, within a specified measurement area, multiple edges can be detected in a selected direction. The Edge Pitch measurement mode measures the maximum values, minimum values and average values of the distances between multiple edges. It is also important to notice, that detection is based on transitions from light to dark (or dark to light), not on the absolute value of the intensity, so it is less affected by illumination fluctuation.

Considering our task, we chose gap pitch as a measurement mode, as the most suitable one. On the following image we can see, that gap pitch allows to detect uniform objects as gaps, and mark their borders.

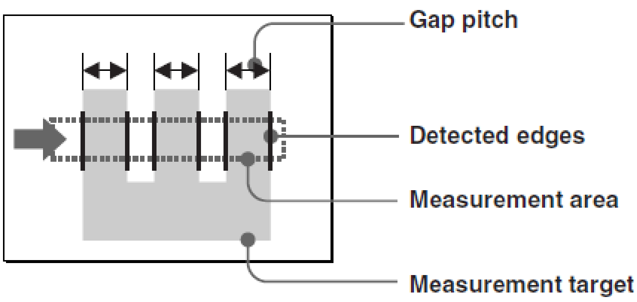


Figure 2.1: Edge measurement

2.1.3 Before measuring

We chose an area, which included exactly three objects in the area of the thinner part of the objects under the caps and didn't move the camera after. Prior to the capturing of the image, it is possible to use image enhancing tools. With the recommendation stated in the manual, we used averaging, but later on added edge sharpening, due to the inability to detect all the 6 edges at once in some experiments.

2.1.4 Measuring process and encountered problems

After performing the measuring, we noticed that the number of pitches most of the time exceeds the real number, which is supposed to be 6. At the same time, the minimum value of the gap was around 1, when the maximum reached 30. This effect can be observed on the picture below. Later, we realized, that it happens due to the detection of multiple edges at the same point, which leads to the measurement being around one, because the gap between these false measurements tends to be small. After some changes in the light, positioning, enhancing settings and camera parameters we were unable to completely eradicate the nature of the problem, so that in all the experiments the number of pitches was exactly six. That is why we decided to restrict the minimum size of the gap, considering working distance of the camera, and the nature of the observed object. We put 5 as a minimum size of the gap and solved the problem. This can be observed in the two following images.

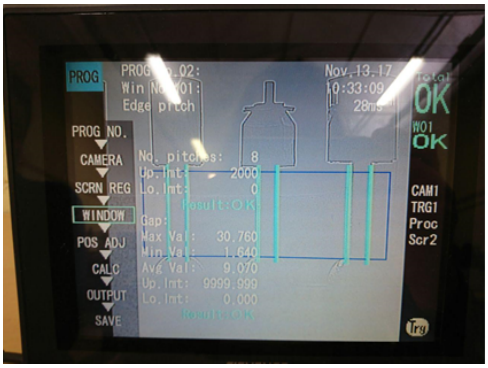


Figure 2.2: Problem encountered

Observation: This is the problem that we encountered while programing the gap measurement, we solve it by changing the setting. As you can see the system decteded 8 pitches where actually only 3 pitches were showing.

Figure 2.3: Settings

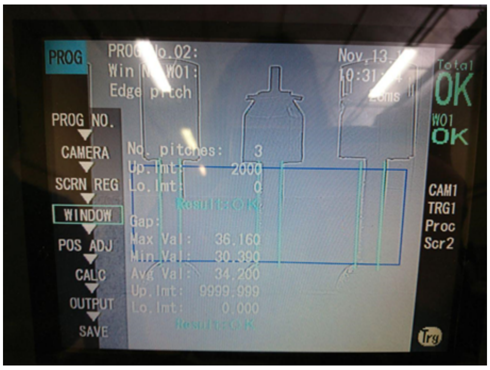


Figure 2.4: Final result

Observation: The final result show the detection of the 3 pitches and the edges of those ones.

2.2 Caps detection

In this part our task is to program the detection of the perfume caps on the holder. We need to select the appropriate tool to perform this detection.

2.2.1 Choosing a tool

For the next task, we didn't have any guidance whatsoever, so we decided to study available tools to perform the detection of the objects with caps and without. In the end, we chose an instrument called "Blob", which we found to be the most suitable for our goals and the task itsekf. Blob is a gathering of pixels having the same intensity (between 255 or 0) within the binary image. In this measurement, the number of blobs, area, center of gravity coordinates, main axis angle, feret diameter, perimeter and roundness in the measurement area are determined. Also, the characteristics to be measured can be chosen.

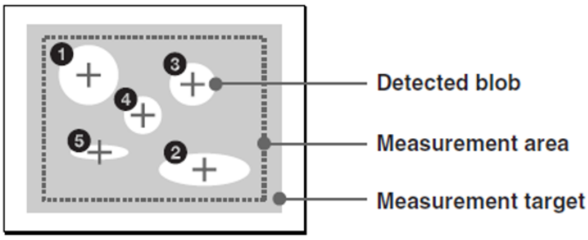


Figure 2.5: Blob detection program

2.2.2 Before measuring

For this task, we chose an area, which included exactly three objects in the area, where the caps should be situated and didn't move the camera after.

Prior to the capturing of the image, it is possible to use image enhancing tools. With the recommendation stated in the manual, we used averaging. During this task edge sharpening didn't play a major role, so we decided to turn it off.

2.2.3 Measuring process and encountered problems

There are various parameters of the blob, which can be measured. We considered our options, and stopped at measuring only the area, due to the static distance towards the objects and the equal sizes of all the objects with caps and equal sizes of all the objects without. Nevertheless, objects with the caps and objects without, have noticeable differences in the area size. We performed the first measurement to estimate the approximate size of the object with a cap and the object without. Afterwards, we put the minimum available area size for the detection above the minimum ? the size of the object without a cap, excluding them from the detection in this way. The results van be observed on the image below.

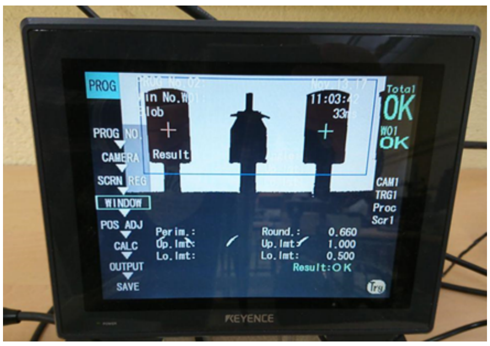


Figure 2.6: Caps detection

Chapter 3

Conclusion

During the completion of this laboratory work, we were working with the high-speed digital image sensor CV-2100 KEYENCE and studying its abilities, functionality and performing basic task.

Our work included detection of the objects and descerning between them through certain means while learning how to operate the device in our control.

In this work we learned how to use to basic measurement tools, such as Edge Pitch, which allowed us to detect edges of the objects and measure various parameters, including distance between them.

Measurement tool Blob was used for the discerning between two types of the objects at hand, based on the area measurement.

Overall, we mastered basics of working with the aforementioned device, and improved our knowledge in the field of image acquisition, using high-speed digital image sensors.

References

1. **High-Speed Digital Image Sensor - CV-2100 User's Manual - KEYENCE**
2. **Smart Camera Definition** `https://en.wikipedia.org/wiki/Smart_camera`