Lab Report-2

Compact Vision System

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1.1 Abstract

Vision Technologies is one of the world leading manufacturers of high-performance digital cameras for industrial image processing. Machine vision (MV) is the technology and methods used to provide imaging-based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance in industry. Following report will introduce high-speed digital machine vision CV-2100 from KEYENCE in the case of Edge detection and pattern recognition.

1.2 Introduction

The goal of this lab was to explore and work on an existing known computer vision system provided by Keyence, and use it for a simple computer vision tasks: *"Edge detection"* and *"Simple Pattern recognition".* For each of those tasks, the system manual has to be read, to select the right processing algorithm and apply the corresponding configuration on the provided software and check the results. The system combines both high speed processing and high-performance capability. Such system has several applications:

1. **Automotive and metal industries:** The CV-2100 Series machine vision system can be used to check machined part quality. In Edge Position Mode, the CV-2100 Series is able to detect and read the machined groove orientation for each gear ensuring high quality parts.

2. **ICs & Electronics Industry:** The CV-2100 Series can be used to differentiate the correct/incorrect sides of chips components to ensure proper insertion orientation. In Intensity Mode, it can detect subtle differences in surface brightness and detect which side of the component is face up.

3. **Rubber and Plastic Industries:** The CV-2100 Series can be used to confirm proper fiberglass panel orientation. In Pattern Search Mode, the CV-2100 easily detects locating marks on each fiberglass panel to ensure proper orientation. Glare and high speed production rates are not a problem.

4. **Food and Packaging Industries:** Use the CV-2100 for beverage can inspections on high speed production lines. In Stain Mode, the CV-2100 Series reliably detects and evaluates flaws on the bottom of aluminium beverage cans.

1.3 Objective

To study and program, a Compact Vision System with the high-speed digital machine vision CV-2100 from KEYENCE.

1.4 Equipment's and Software

Controller unit (CV-2100)

Remote control console (OP-42342)

Monitor cable (RCA - RCA, 2 m)

Camera (CV-020)

CV-C3: Camera cable (3 m)

Monitor CA-MN80

24 V DC power supply

Industrial Parts and Backlight

Software: Embedded KEYENCE Software

Documentation: User Manual - High-speed Digital Image Sensor CV-2100

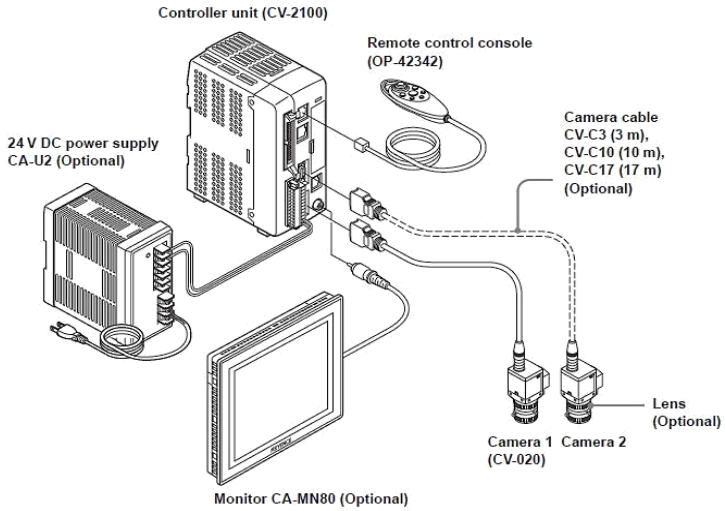

Fig1 Compact Vision System

2.1 Edge Detection:

• The camera setup highly impacts the results of the tests, at the beginning the camera was at full aperture but due to the high random lighting surrounding, the edges had high reflectivity due to the light, and couldn't be correctly detected, so we had to fix the aperture to get correct result. The following image shows double edges detection at some edges due to the lighting problem: (The maximum and minimum distance between edges are not the same meaning that multiple edges detected at some points or no edges at others).

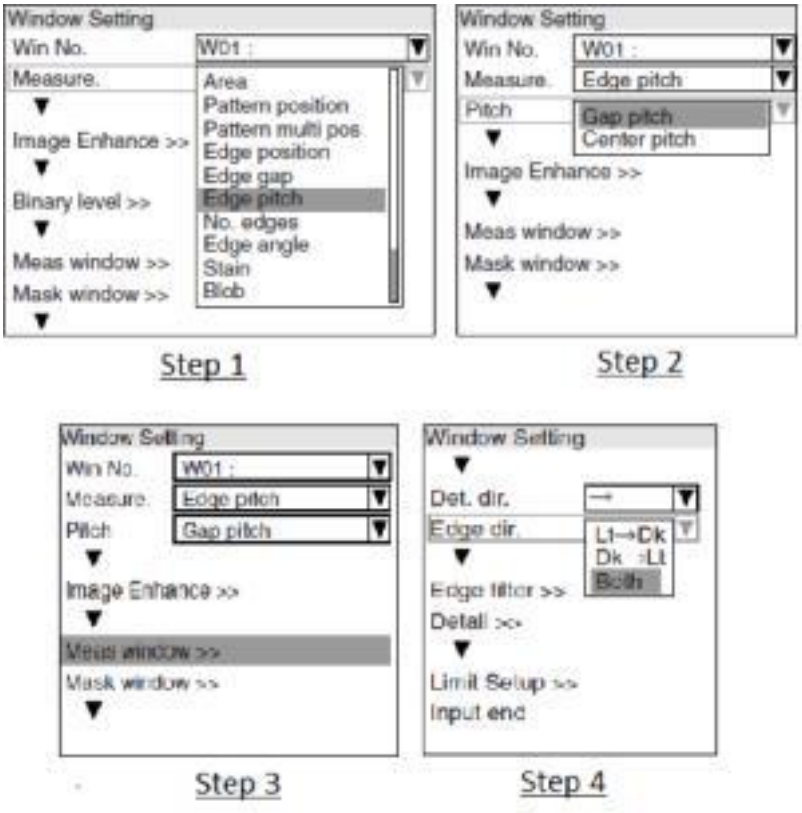

Fig2 Setting up the system to detect edge

• Also the selection of the pre-processing technique to be used for image acquisition, affects massively the result of edge detection. We tried the “Edge Extracting” pre-processing technique, which didn't lead to correct results because of the interference with the incorrect lighting conditions, and also the high sensitivity of the pre-processing on the input image,

which impacts the edge detection process itself. The “Edge Extracting” is a pre-processing technique that extracts regions where there is a change in intensity.

2.2 Results of edge detection

fig3 objects with reflected light

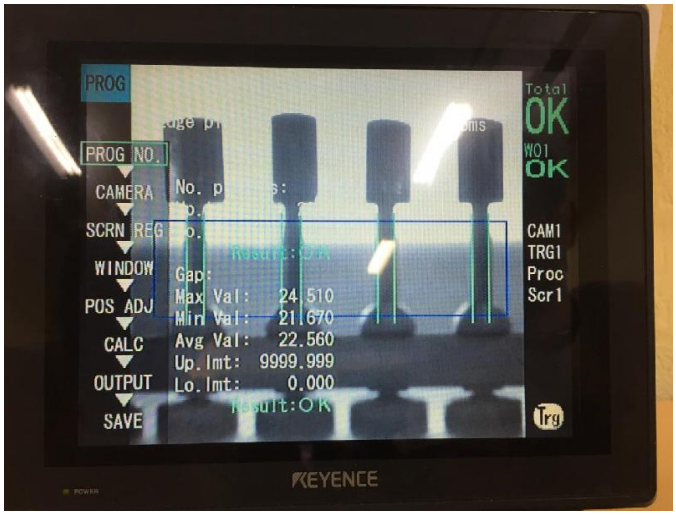

fig4 detected edges

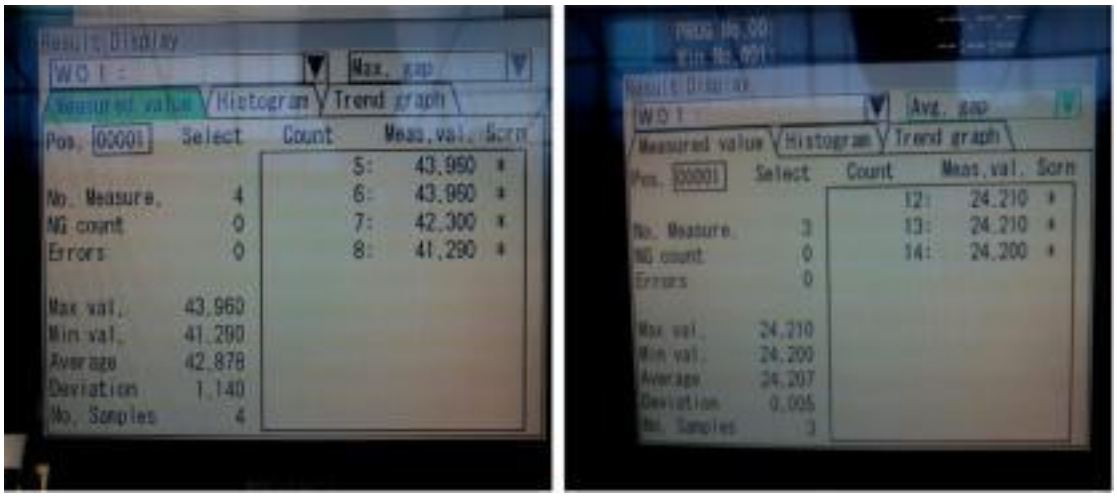

Fig5 Maximum and average gap between the detected edges

3.1 Caps Detection:

• In this experiment the goal is to detect a specific pattern, like for so many applications the goal is to detect defect/problems by having a binary output (zero/one) to identify if certain object follow the searchable pattern or no. So we have used “Pattern search” as algorithm.

• In the existing system, we had two different patterns, a rectangular one and a polygon. So we will never be able to have a pattern to recognize both of them, so we have defined two different pattern, and executed two different experiments, assuming that in each one of the pattern is the good desired one, while the other is defective.

• For the first type of objects, a simple rectangular window was used, and we had to adjust the window size not to be too big so that more than one object exists at one time in the window (unpredictable results perceived for big window size, mainly depending on the lighting at certain point, for example, if the window contains two patterns, it can detect one of them or both), and not to be too small to destroy the pattern to be recognized.

• The orientation of the object also can affect the result of pattern recognition, if its oriented by an angle that makes the surface of the object in front of the camera not rectangular anymore or the size of this surface is dramatically less (or greater) than the predefined pattern, the recognition then will be affected.

• To be able to detect the other type of objects we had, we had to design a window pattern to be able to detect it, the *“polygon pattern window”,* is the most flexible pattern that can be used to fit irregular shapes, so we draw a pattern that exactly has the same shape as the object border, thus we were able to detect this type of objects.

• We can see that this strategy of looking for a pre-defined known pattern is not flexible or dynamic, to add more patterns to be detected more pattern windows need to be defined, and we will not be able to detect different types of objects at the same time .But we still can define several window pattern and apply more than one at the same time in order to obtain better results for complicated patterns, but of course such configuration is more advanced, and the choice of several patterns and how they interact to filter the object become more complicated.

3.2 Results of cap detection

We tried the method with a second caps to see if the program does the difference between the holder with / without caps.

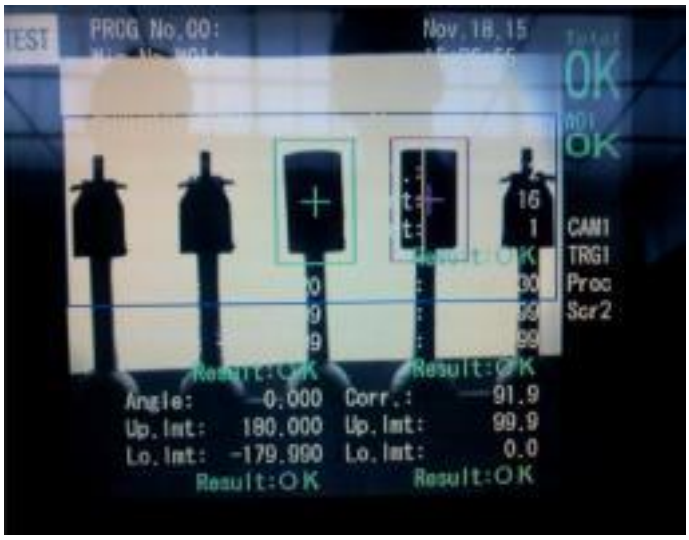

Fig6 Detection of a second cap

Contrary to the method Pattern Search, the method Multiple Pattern Search allows to detect several caps.

fig7 Detection of 3 different caps

Even if this method is a success, we wanted to see what his limits. We raised one of the perfume caps to see if it's detect and the result is no.

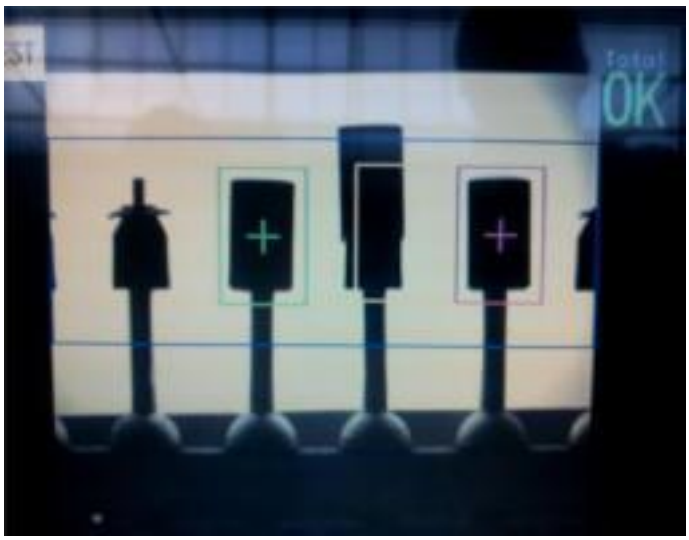

Fig8 Error in the detection of the 3rd cap

Conclusion:

Edge detection and Cap detection are realised using Compact Vision System.