
SMART CAMERA

APPLICATION DESCRIPTION

APPLICATION: PART IDENTIFICATION

INDUSTRY: AUTOMOTIVE

PRODUCT: BATTERY TERMINAL CLIP



BACKGROUND AND CONCLUSION



FIGURE 1: SAMPLE PARTS

A manufacturer of automotive components needs to identify parts in the manufacturing process. Differences in appearance among the parts are subtle and not easily discernable by humans at production rates, so an automated solution is being explored. As of this writing no material handling system has been proposed, but it is assumed that, due to their shape, the parts shall be presented with the identifying feature pointed upward in a repeatable orientation on a belt conveyor. Although at present, the Smart Camera functionality need only include the ability to reject a non-conforming part, functionality to perform part sorting at a later date should be included. This report documents the vision application with regard to the sensor location, lighting, optics and methodology to perform the inspection.

Testing was performed using the “simulator” function of the Smart Camera. Pictures of the parts were taken with a cell phone and imported into the image buffer of the Smart Camera for processing. Even under less-than ideal conditions related to lighting, focus and scale, the Smart Camera was able to ascertain the difference between the parts in question.

Figure 1 is a photo of the sample set of parts. Of concern is the area on the post that contains either a “+”, a “-” or no mark.

With the appropriate lighting and optics, the Smart Camera is an effective tool to determine the marking at the top of the post.

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INSPECTION STATION OVERVIEW

Normally Figure 2 contains a picture of the laboratory setup for the part inspection application. Because the simulator was used (see below), this figure is blank.

Following are specific simulator parameters:

Smart Camera (0.3 MP)

- 10mm lens
- Working Distance (WD): Approximately 200mm;
- Field of View (FOV): approximately 30mm in the greater (y) dimension.
- Illumination: Top Light

Note: WD, FOV and lighting are approximations due to simulator.

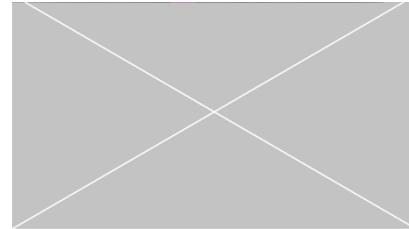


FIGURE 2: INTENTIONALLY BLANK

Smart Camera setup/ configuration are performed on a PC connected via an Ethernet cable. Once configuration is performed, the sensor operates stand-alone and the PC is not required. The Ethernet connection, however, may be used for data transfer (e.g. location, bar code, OCR) via TCP/IP for applications such as motion control and data acquisition. The sensor can store up to 255 configuration recipes (“jobs”). The Smart Camera has 5 digital inputs and 5 digital outputs. These are used for such functions as image acquisition, job selection, part reject, etc.

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VISION 1-2-3: IMAGE- TOOLS- I/O

Inspection setup with Smart Camera is simple and intuitive. The configuration software consists mostly of drop-down menus and slide bar adjustments. There are few text entries required, and no programming or scripting. There are three steps to configuring the Smart Camera, each of which is described in detail for this application below:

- 1) Adjust Image
- 2) Select the appropriate vision tool
- 3) Configure Input/ Output Interfaces

When these three steps are completed, simply download the configuration parameters from the PC to the Smart Camera.

STEP 1: ADJUST IMAGE

The first step of any automated visual inspection is to establish proper part positioning, lighting and lens focus. The intent at this step is to obtain a part location, Field Of View (FOV) and lighting scheme appropriate for the necessary inspection algorithms (“Tools”).

The picture in Figure 3 illustrates the lighting variation that occurs due to differences in position between the light source and the part. In this picture, taken with a cell phone for use by the Smart Camera simulator, the light source is near the center and from the top. Note the brightness of the center part. As the parts to the right and left are located further from the center light source, eventually an acceptable location enhances the part attributes to be inspected: the “+” sign at the extreme left



FIGURE 3: ADJUST IMAGE

and the “-” sign, seen best second from the right.

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STEP 2: CHECK FEATURES

Step 2 is to select the proper software tools to perform the required inspection(s). The Smart Camera is equipped with a complete software library of powerful vision algorithms including:

100 Series:

- Pattern Recognition
- Normalized correlation
- Edge Detection
- Connectivity Analysis
- Grey scale Histogramming

These algorithms permit functions such as:

- 360 degree part location
- Image template matching
- Measurements and Dimensions
- Feature extraction (area, x/y location, brightness)

200 Series:

- All 100 Series tools described above
- Bar code read and quality
- Matrix code read and quality
- Optical Character Recognition (OCR)
- Optical Character Verification (OCV)

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In this application only one software tool was required, the “Locate on Contours Tool.”

Figure 4 is a screen capture of the negative post. This is the part that is taught and to which subsequent images will be compared.

Figure 5 is a screen capture of another negative post. Note that, although the part is somewhat further away from the camera, appearing smaller, the pattern is still located. This demonstrates a degree of scalability of the Locate on Contours Tool.

Figure 6 is a screen capture of a positive pattern. Note that it fails, as indicated by the red circle.

Figure 7 is a screen capture of another positive pattern; it also fails.

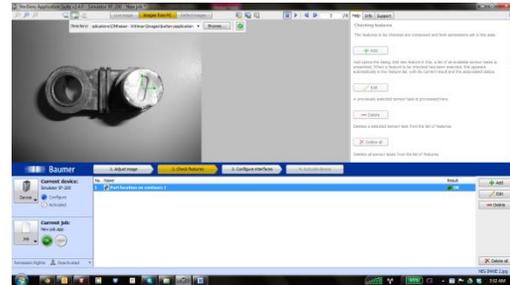


FIGURE 4: NEG TAUGHT

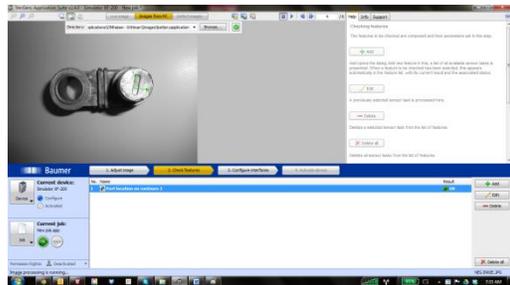


FIGURE 5: NEG PASS

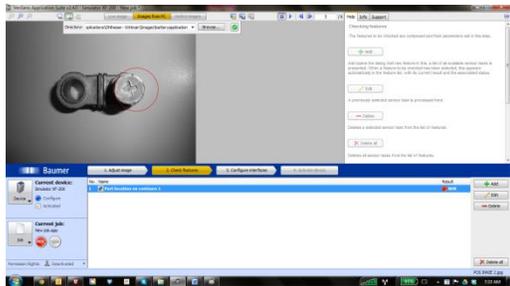


FIGURE 6: POS FAIL

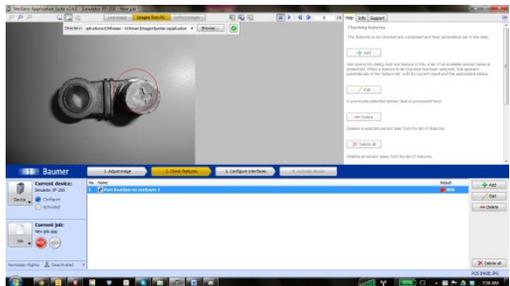


FIGURE 7: POS FAIL 2

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STEP 3: CONFIGURE INTERFACES

Step 3 is to configure the outputs. The Smart Camera has 5 digital inputs and 5 digital outputs. In this instance, one of five digital outputs can be assigned to provide a signal corresponding to a non-conforming condition. This digital output is sent to the machine's reject circuit.

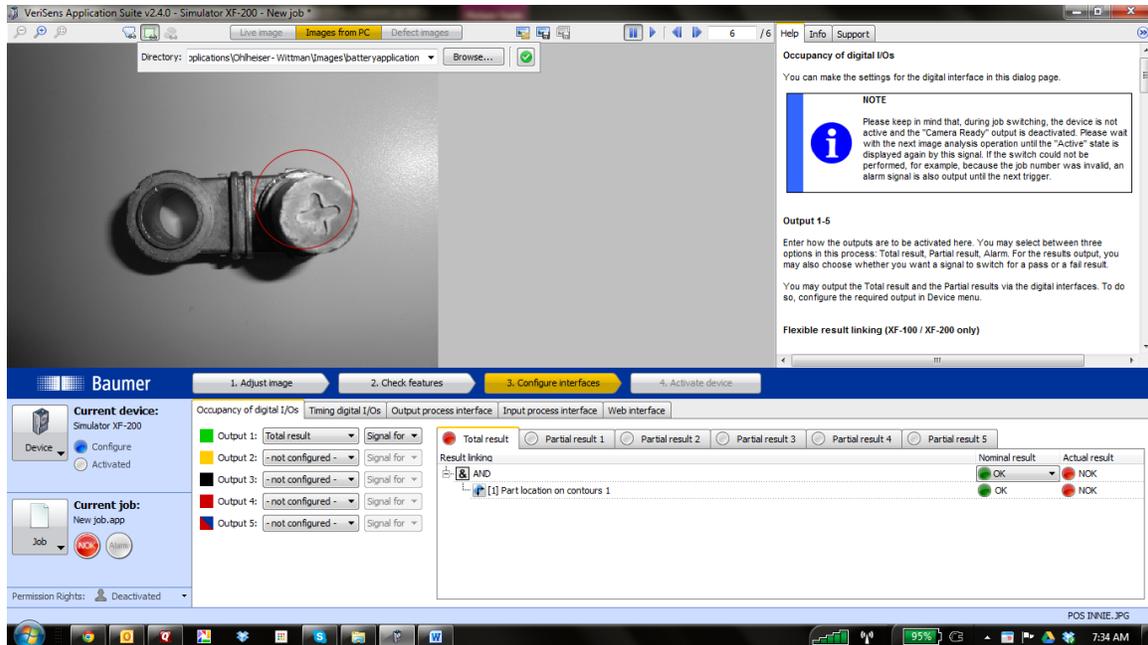


FIGURE 8: CONFIGURE OUTPUTS

Figure 8 illustrates the ability of Boolean logic functions to be utilized in assigning vision tool results and combinations thereof to various outputs. This satisfies the potential future requirement of this application to sort parts based upon whether the post has a “+”, “-” or no imprint.

The Smart Camera also can transmit via TCP/IP ASCII data corresponding to results values, positional information, good and bad images, etc.

STEP 4: ACTIVATE SMART CAMERA

Step 4 is to simply download the configuration parameters to the Smart Camera. The job may also be stored on the configuration PC prior to activation. Once activated, Smart Camera functions as a stand-alone sensor and the PC can be disconnected.

OPERATION

No operational criteria were submitted.

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DELIVERABLES (SOME ITEMS BY OTHERS)

A typical system contains the following (one per lane):

- (1) Smart Camera
- (1) Connector Cable for power and I/O
- (1) Ethernet cable
- Smart Camera Installation assistance and training: one day
- Lighting (internal)
- Optics (internal)
- Part handling (by others)
- Peripheral equipment (Power supply, enclosure, I/O terminals, annunciator, etc.- by others)
- Engineering and documentation (by others)

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CONTACT

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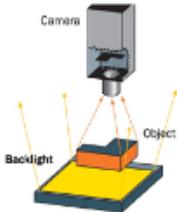
865-223-3578

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GLOSSARY

Back Lighting

Lighting technique in which the light source and the camera are on opposite sides of the part to be inspected.



Contrast

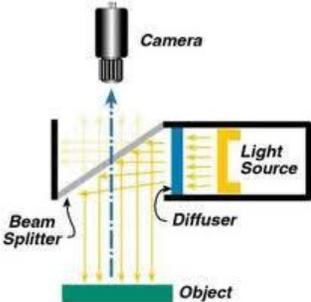
Measured in grayscale (Black = 0; white = 255).

A minimum contrast must be present in order to differentiate a feature from its background.

BACKLIGHT

Dual On Axis Light

(DOAL) On Axis illumination uses beam splitting techniques to enable the illumination to be positioned between the camera and the object so that the camera is situated behind the light. Note: Due to light loss in the beam splitter the unit generally needs to be positioned as close as possible to the object.



Edge Detection

A software tool that calculates the gradient location across a pixel matrix based upon the difference between the grayscale values. Typically, a nearest line fit is calculated across several pixels within the maximum gradient and this line is determined to be the edge.

Feature Extraction

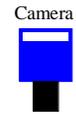
The ability of machine vision software to separate a feature from its background and determine some attribute (area, brightness, etc.)

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Front (or Top)

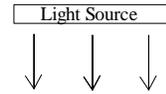
Lighting

Lighting technique in which the light source and the camera are on the same side of the part to be inspected.



Gray Scale

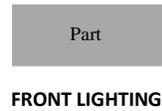
In an 8 bit monochrome system, black =0 and white = 255 with values between depicting varying shades of gray.



Optical Character

Recognition (OCR)

The ability of machine vision software to determine the value of a string of previously unknown characters.



Optical Character

Verification (OCV)

The ability of machine vision software to determine whether or not the value of a string of previously taught characters matches the current image.

Resolution

Measured in Units of measure per pixel.

Field of View ÷ minimum number of pixels on the sensor. For example, a 1" FOV with a VGA sensor has a resolution of approximately .002"

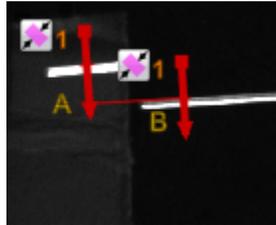
$$\text{Resolution} = \text{FOV}/\text{pixels} \quad \text{Resolution} = 1"/480$$

$$\text{Resolution} = .002"/\text{pixel}$$

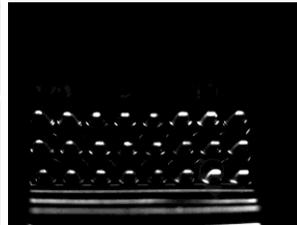
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Structured Lighting

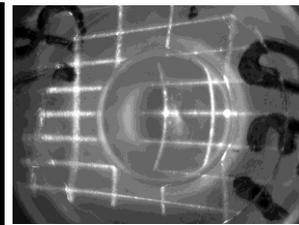
Lighting technique whereby the illumination source has a defined geometry: line, grid, pattern, etc. It is often employed to obtain geometric information about a part that is inspected. The vision system measures attributes of the light pattern in order to obtain information about the part. Below examples are: (1) Line used to determine vertical displacement on a paper feed; (2) three line pattern used to count crayons in a box; (3) Grid used to detect 3D contour information.



PAPER VERTICAL
DISPLACEMENT



CRAYON COUNT



GRID PATTERN

Threshold (Gray Scale)

With binary algorithms, the gray scale value above or below which the pixel values will be recognized.

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