
VERISENS® APPLICATION

STUDY

APPLICATION: HIGH DEPTH LOCATION

INDUSTRY: MATERIAL HANDLING

PRODUCT: N/A



BACKGROUND AND CONCLUSION

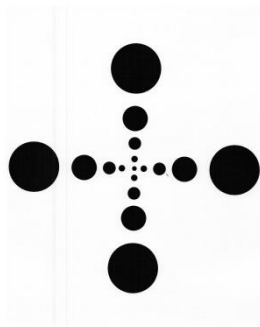


FIGURE 1: BLOB TARGET

A provider of equipment to the material handling market has asked that Baumer examine the properties of their low-cost VeriSens® vision sensor as it might apply to a high depth of field application, in this instance approximately 7 feet to 40 feet. The objective is to determine the location of an object throughout the entire field depth.

Figure 1 is a picture of the target used with the “Count Areas” Tool. This pattern was conceived as a result of considering the tool set available on VeriSens® and the task to be performed.

The concept of the tool/ pattern combination is to have four and only four dots recognized by the vision sensor nearly continuously as it traverses through the depth of field. The x, y locations of these dots would be transmitted to a controller for its appropriate action.

The conclusion is that this concept is viable with further refinement in the relationships of dot size and distance. This is a function of the target design, not the vision sensor. Below is documented the test methodology and results.

INSPECTION STATION OVERVIEW

Testing was performed using a Baumer VeriSens® XF100 with a 1.3 Megapixel sensor. Pattern samples were placed onto a flat, top-lit surface.

Following are specific lighting and optics parameters:

XF100 (1.3 MP)

- 6mm lens with polarizer
- Working distance: 3-47 inches;
- Field of View (FOV): Range of 11" to 2.5" Wide
- Illumination: Diffuse Top Light

VeriSens® 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 via TCP/IP for applications such as motion control and data acquisition. The sensor can store up to 255 configuration recipes ("jobs"). VeriSens® has 5 digital inputs and 5 digital outputs. These are used for such functions as image acquisition, job selection, part reject, etc.

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

Inspection setup with VeriSens® from Baumer is simple and intuitive. The “AppSuite” 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 VeriSens® vision sensor, 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 VeriSens®.

STEP 1: ADJUST IMAGE

The first step of any automated visual inspection is to establish proper part positioning, lighting and lens focus. Figure 3 illustrates the raw image applying a back light.

The intent at this step is to obtain a lighting scheme appropriate for the following inspection algorithms (“Tools”).

Because the lab does not possess a means to physically position a vision sensor across a 7’ to 42’ depth, in this test the vision sensor was positioned from 47” above the target to 3” above the target. The intent is to demonstrate the concept of the tool usage on the pattern. Under these conditions the apparent brightness and size will change. Figure 3 shows the image window of the pattern with

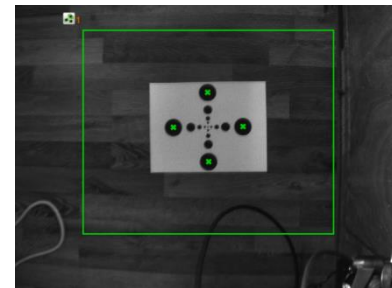


FIGURE 3: ADJUST IMAGE

the sensor at a height of 47”.

STEP 2: CHECK FEATURES

Step 2 is to select the proper software tools to perform the required inspection(s). VeriSens® 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 used, the “Count Areas” Tool. The Count Areas Tool has four primary adjustments: Bright on Dark/ Dark on Bright, Binary Threshold and an Area Filter with high and low adjustments.

Figure 4 is a screen capture from the pattern loaded into the VeriSens® simulator. The criteria have been set as “Dark on White” and the area filter slide bars have been selected to recognize only the largest dots. The idea is that, as the vision sensor distance to the target decreases, the largest dots are either no longer within the required area limits or are no longer within the Field Of View. At

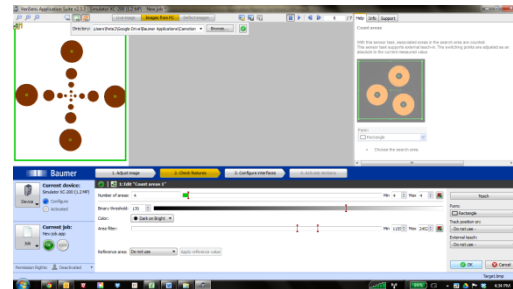


FIGURE 4: COUNT AREA TOOL WITH AREA FILTERS

this point the next smaller dot is seen as the largest and is recognized by the vision sensor. As the distance to the target continues to decrease, the process is repeated with smaller and smaller dots.

Figure 5 is a screen capture with VeriSens at 47.5 inches. Here is seen the recognition of the largest dots.

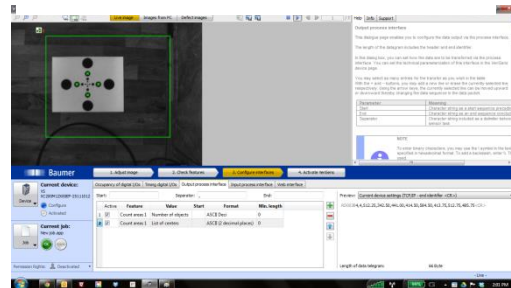


FIGURE 5: HEIGHT: 47.5 INCHES

Figure 6 is a screen capture with the sensor at a height of 37.5 inches. Here is seen that the next smaller dots have met the area filter criteria for recognition.

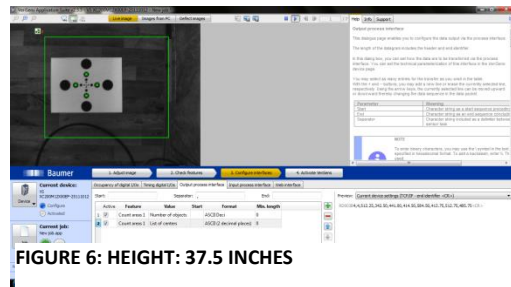


FIGURE 6: HEIGHT: 37.5 INCHES

It is possible that, at some heights, largest dots may become too large to be recognized and the smaller dots are not yet large enough to be recognized, perhaps due to the “Minimum” and “Maximum” settings of the Area Filter Slide Bar. This is illustrated in Figure 7.

Figures 8 and 9 on the following page show the images at heights of 15 inches and 3 inches respectively.

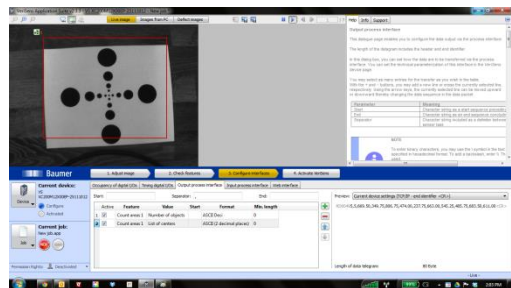


FIGURE 7: HEIGHT 20.5 INCHES

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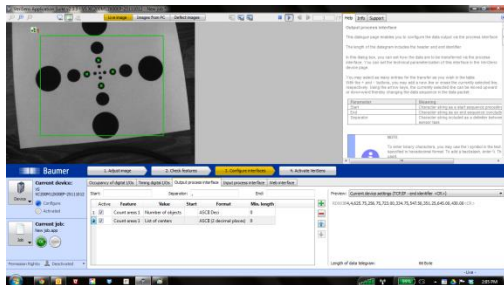


FIGURE 8: HEIGHT 15 INCHES

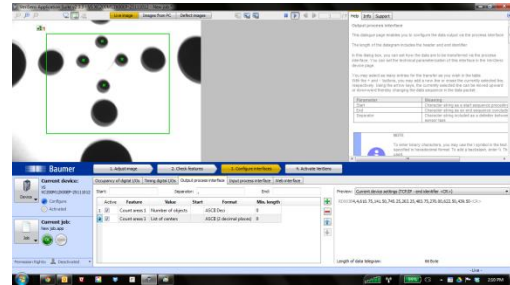


FIGURE 9: HEIGHT 3 INCHES

STEP 3: CONFIGURE INTERFACES

Step 3 is to configure the outputs. VeriSens® 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.

Additionally, the VeriSens® has the ability to transmit via TCP/IP ASCII data corresponding to results values, positional information, good and bad images, etc.

In this instance output data for the x,y location of each dot would be transferred to a lookup table via TCP/IP and the center would be calculated.

STEP 4: ACTIVATE VERISSENS

Step 4 is to simply download the configuration parameters to the VeriSens®. The job may also be stored on the configuration PC prior to activation. Once activated, VeriSens 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) Baumer VeriSens® XC-100: VC XC100M12X00EP
- (1) Baumer Connector Cable for power and I/O: ESG 34JP0200G Flying Lead
- (1) Baumer Ethernet cable: KSG34A/KSG45AP0200G/E
- Baumer VeriSens® Installation assistance and training: one day- no charge
- Lighting (by others)
- Optics (by others)
- Part handling (by others)
- Peripheral equipment (Power supply, enclosure, I/O terminals, annunciator, etc.- by others)
- Engineering and documentation (by others)

Please contact your Baumer representative for a budget estimate.

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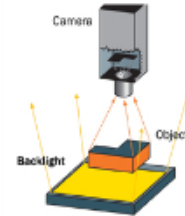
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GLOSSARY

Back Lighting

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

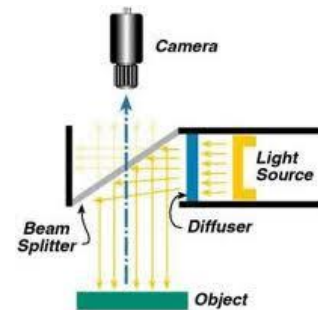
**Contrast**

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.

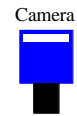
Feature Extraction

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

Front (or Top)

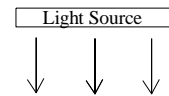
Lighting

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



Gray Scale

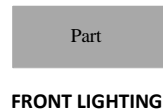
In an 8 bit monochrome system, black =0 and white = 255 with values between depicting varying shades of gray.



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.