VERISENS® APPLICATION DESCRIPTION

APPLICATION: READ BAR CODE AT SEVERE ANGLE

INDUSTRY: CONSUMER PRODUCTS

PRODUCT: LABEL

BACKGROUND AND CONCLUSION

A major manufacturer inquired regarding the ability of the Baumer VeriSens to read a bar code at a severe angle. No material handling system was specified for this report, so the part presentation apparatus is unknown. This report documents the vision application with regard to the lighting, optics and tool selection.

FIGURE 1: SAMPLE PART

Figure 1 is an image of the part. Of concern is the variation of the focus across the part and the extreme parallax. Note that on this sample the lower portion of the part is defocused, while the upper portion of the part is not. This indicates a variation in the depth of field across the vertical portion of the image. The lighting and optics of the vision sensor must be selected to minimize this.

Testing was performed with the sample set above. Within parameters described below, it was determined that the Baumer VeriSens® vision sensor is able to read the bar code as required.

INSPECTION STATION OVERVIEW

Figure 2 is a picture of the laboratory setup for this application. Testing was performed using a Baumer VeriSens® XC200 with a 0.3 Megapixel sensor (VGA). The sample part was placed on a flat surface. Lighting was from the top and diffuse with some ambient.

Following are specific lighting and optics parameters:

XC100 (0.3 MP)

- 35mm lens
- Working distance: 18" (457mm);
- Field of View (FOV): approximately 1.75" (45mm) in the greater (x) dimension.
- Illumination: Top, diffuse

FIGURE 2: LABORATORY SETUP

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").

Note the extreme distortion of the image due to the large angle. Special attention must be paid to the lighting and aperture adjustments in order to maximize the focal distance across the vertical Field Of View. Subsequent steps illustrating the application and use of the Barcode Tool will illustrate a technique to obtain the best possible results under less-than-optimal circumstances.
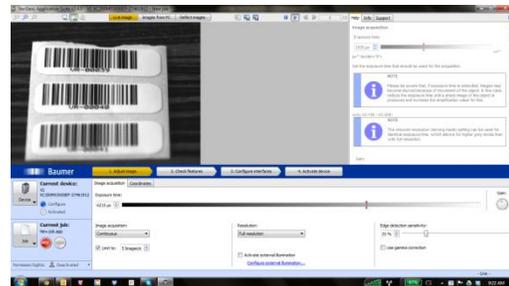

FIGURE 3: ADJUST IMAGE

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)

In this application only one software tool was needed, the "Barcode" Tool.

Figure 4 is a screen capture of a carrier with three labels, each with a different bar code. In order to optimize the focus across the entire Field Of View, the center label is used as the reference. The green color of the Region Of Interest indicates that the vision sensor is able to read the bar code. In order to determine the optimal conditions for the read considering lens focus, the "Quality: Calculate based on ISO/IEC 15416" drop down is

FIGURE 4: CENTER BAR CODE READ

enabled. Examining the change in Quality values as the lighting and focus change enables one to maximize the reading of this ROI. Note the readings are "ADAADAAA" for decodability, symbol contrast, minimal reflectance, edge contrast, modulation, defects, decodability, and additional code-specific parameters.

(Additional details about the quality characteristics may be found in the Baumer VeriSens AppSuite Help File, Appendix: Quality characteristics for barcodes and matrix codes).

Figure 5 illustrates the same tool positioned at the upper bar code. Note the quality values of FDAFFFFF. This Quality grade indicates that the upper portion of the Field Of View is not preferred.

Figure 6 illustrates the tool positioned at the lower code. Here the reading is "ADAABAAA", slightly better than the center code. If this were the actual conditions on the
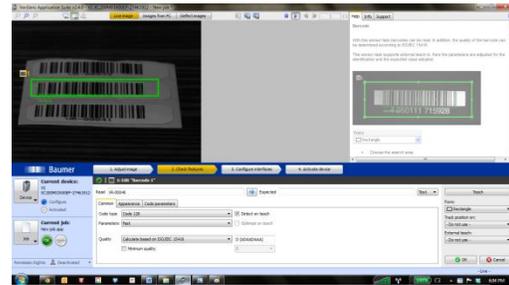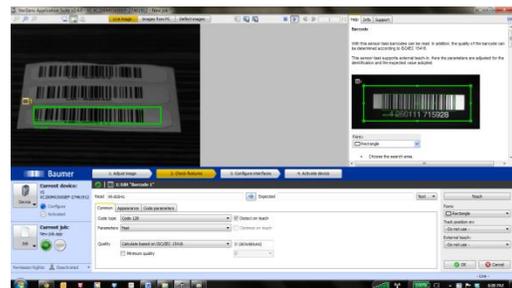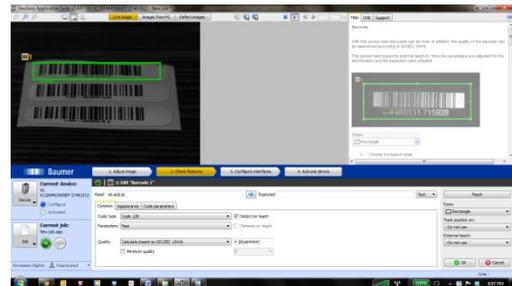

FIGURE 6: LOWER BAR CODE READ

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.
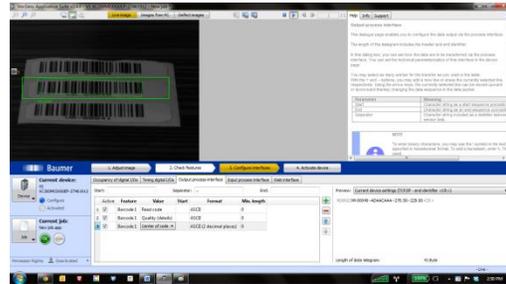

FIGURE 7: ASCII DATA OVER TCP/IP

In this application the ASCII string is separated by a user defined set of characters ("—" in this instance). Three parameters were selected for transmittal: the bar code value, the detailed quality values and the x,y location of the bar code.

STEP 4: ACTIVATE VERISENS

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

Although no operational criteria were specified, the VeriSens web interface may be of use. From the web interface one may address the IP address of the sensor and read data and image information, as well as make certain set point changes.

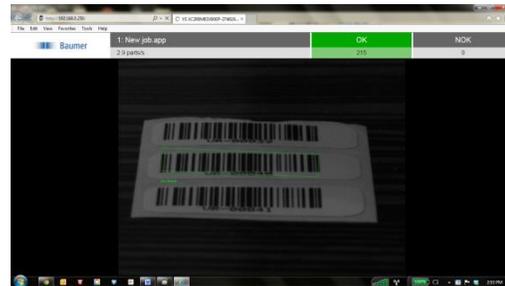Figures 8 and 9 illustrate the Baumer VeriSens Web

Interface.

FIGURE 8: WEB INTERFACE OPERATING PAGE

FIGURE 9: WEB INTERFACE CONFIGURATION PAGE

DELIVERABLES (SOME ITEMS BY OTHERS)

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

- (1) Baumer VeriSens® XC-100: VC XC100M03X00EP

- (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.

CONTACT

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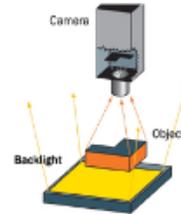Jon Chouinard, Vision Products Business Development Manager, East

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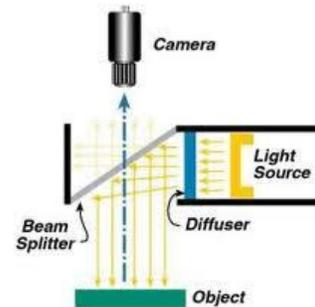
Edge Detection A software tool that calculates the gradient location across a pixel matrix based upon the difference between the grayscale values. Typically, a nearest line fit is calculated across several pixels within the maximum gradient and this line is determined to be the edge.

f-number ("f-stop") The f-number N is given by

N = f\D

where f is the focal length, and D is the diameter of the entrance pupil (effective aperture).

It can be seen by this equation that the smaller diameter of the aperture, the greater the focal length.

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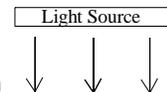
Front (or Top)

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.

Camera

Light Source

Part

FRONT LIGHTING

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 Resolution describes the number of pixels across the Field Of View of the sensor (e.g. pixels/ mm). Often its inverse is calculated for measurement tolerance in units of measure per pixel as:

R = FOV\pixels

where R is the unit measure of each pixel, FOV is the Field of View of the major axis of the vision sensor and pixels is the number of pixels in the major axis of the sensor chip.

For example, a 30mm FOV with a VGA sensor (640 pixels) has a resolution of approximately .05mm.

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