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1. DESCRIPTION

1.1 Description

The Vision System is based upon a standard PC platform. The Industrial PC (IPC), which contains an Intel® i7-6700TE processor and 6 onboard network ports, is designed for machine vision and automation.

This system includes three Basler acA1440-73gc area scan, full frame, color cameras. They each have a 1/3" CMOS sensor with 1440 x 1080 resolution.

There is one white 4" x 8" LED backlight and two 4" x 4" backlights mounted in the camera enclosure opposite the cameras. As this vision system has an encoder to track a defective product as it moves along the conveyor belt, an Allen Bradley Micro Logix 1400 PLC is included. The PLC triggers the camera and tracks the bottles until the defective parts are opposite the reject station.

To reduce weight and the potential for voltage irregularities, an air to air heat exchanger is used in place of an air conditioner. To further pull heat out of the control enclosure a water to air heat exchanger is attached to the CPU.

The operating system is Windows® 10 IoT. The operator interface consists of .NET application. The functionality consist of Silgan’s optimized machine vision inspections.
2. INITIAL HOOK UP & SETUP

2.1 Initial Hook up & Setup

As this system uses an industrial PC, the cabling to the monitor, mouse, and keyboard are standard connections. A roll up keyboard is included with the system. These are used only to access applications other than the vision program. All programming for the vision application is performed with the touchscreen.

The main power connects through a 3/4" watertight connector, and requires 10 amps at 120VAC. If remote monitoring of the collected data is needed, a network cable can be fed through the 3/4" watertight connector that shares the encoder cable and into the control enclosure.

The standard encoder, provided with the Vision System, has 600 pulses per revolution (ppr). It works well with conveyor sprockets from 3.5" to 6" in diameter. Sprockets smaller than this should use a 300 ppr encoder. Sprockets above 6" should use 900 ppr. Conveyor speeds can be at 150' per minute or below. Higher speeds with a sprocket smaller than 3.5" will require an encoder with less than 600 ppr. The encoder has a quick disconnect connector, and a cable length of 25 feet.

The control enclosure is mounted on a stainless steel pole. It must be located within 10 feet of the camera enclosure. From a usability standpoint, the nearer the control enclosure is to the camera, the better. The touch-screen is mounted inside the control enclosure. It pivots 320° and may be rotated to face the conveyor. The main connection between the control enclosure and the camera enclosure is through a 24 pin quick disconnect cable assembly.

The reject station must be located no further than 32 bottle diameters from the camera enclosure. Greater distances can be achieved but reprogramming the PLC will be necessary. The current eject signal out is 24VDC at 1 amp.

The Down Bottle Sensor should be positioned on the side where bottles enter the system. The Down Bottle Sensor must be placed half a bottle width before the Part Present Sensor that is mounted in the camera enclosure. As the bottle leaves the Down Bottle Sensor, the Part Present Sensor must be on. The reflector must be located directly across the conveyor from the sensor. To activate, choose Ejector Settings -> Down Bottle Sensor from the Main Page. Then check the Down Bottle Sensor checkbox.
3. INTRODUCTION TO THE MAIN PAGE

3.1 Introduction to the Main Page

Status Bar: The top row of buttons show the current status of the system and allow the states to be toggled. Change a recipe, toggle online/offline, login/logout by touching the button.

Image Bar: The second row of buttons includes functionality for manually triggering the cameras and determining which set of images to display.

List of Inspections: This lists all the inspections that the vision system is capable of performing. Touch an inspection to configure it.

Inspection Results: Green border indicates that particular inspection Passed, Red indicates failed, and Grey indicates that inspection was disabled.

Function bar: The bottom row of buttons include features for configuring the system.

Step control: Controls the amount of change made during configuration.

Lateral Proximity indicator: This number indicates the lateral deviation (closer or farther from camera 1) for the current bottle on the conveyor with reference to the taught position. Once setup, this number should be as close to 0 as possible during the production run as this indicates whether the bottles are coming in at the same position under the camera tunnel or not.

Figure 3-1: Understanding the Main Page
4. OPERATION

4.1 Operation

The vision application is scheduled to run after boot up. On startup, the operator is prompted to login (Figure 4-1). After the login process, the user must select a recipe (Figure 4-2). The main page will then load (Figure 4-3).

*Note:* You will need to familiarize yourself with the security system before you will be able to access the setup menus (Section 6).

![Login Page](image1)

*Figure 4-1: Login Page*

![Select a Recipe](image2)

*Figure 4-2: Select a Recipe*
4. OPERATION

Figure 4-3: Main Page

4.1.1 Setup

Step 1 - Camera Configuration (First Time Set-Up)

Photo-eye Direction: This must be set to let the system know if the bottles are traveling from the right or the left.

Trigger Delay: This is the time between the bottle tripping the photo-eye and the time the picture is snapped. The delay setting should be set so that the bottle appears to be positioned the same distance from the center in both bottom camera windows.

Note: Be sure you double check this setting passing one bottle at a time. It is very easy to accidentally setup on the second bottle if there is a steady stream.

Ejector Settings: Adjust ejector settings. Touch the ejector button.

Digital I/O Setup: This allows the Vision System to be tied to another piece of equipment. Such equipment may kickoff a set number of bottles on startup, or signal when there are a specified number of consecutive rejects.
4. OPERATION

Recipe Settings: The current Recipe is displayed in the Status bar, in the top left. From the main page, touch the recipe name. The recipe dialog box will open. Select a New Recipe, enter a name and press the OK button. Any parameters changed from this point on will be saved with the current recipe.

Once a recipe has been set up and used, it will be saved for retrieval at a later date. To use the settings from this recipe for another recipe, select the recipe and touch Copy Settings To New Recipe. You will be prompted to enter the name of the recipe.

Step 2 - Adjust Enclosure Height

Place a bottle on the conveyor, so it is centered between the two bottom cameras. From the Main Menu, choose Camera then use the arrow buttons to Adjust Enclosure Height. Press up or down to adjust the height until the middle of the cap is level with the Part Present Sensor (Figure 4-4). After the height has been set, the value seen in the edit box will be saved. After opening a saved job, the height will automatically adjust back to the saved value when the start button is pushed. The start button will be displayed in a pop up dialog box.

Figure 4-4: Adjust Enclosure Height
4. OPERATION

**Step 3 - Adjust the Light Level**

Adjust the light level by modifying the **Exposure Time**. Touch an image to select a camera, then using the up and down arrow buttons increase or decrease the exposure time until the bottle has dark edges around its entire perimeter. The software requires sharp contrast to reliably identify edges. The image can rarely be too dark unless the background at the edge of the picture starts to turn too dark *(Figure 4-4)*.

If the arrows appear to do nothing when pressed, be sure there is a camera selected.

*Note:* The step control in the bottom left corner of the page controls how much the arrow buttons change the values.
4. OPERATION

Step 4 - Configure Height Inspections

Select one of the first four inspections by touching the box in the Inspection List on the left side. Configuration for those inspections will open.

1. The last acquired image will be used to “teach” the Vision System to recognize an acceptable bottle and cap combination. If this image is not useful, touch Grab Next to use the next image the vision system captures. Select an image of the bottle and cap that is relatively normal. Ensure it is not significantly different from the bottles to be inspected. The system is very tolerant and does not require sampling. However, the bottle neck and cap cannot be visually abnormal. Trigger and Timed Trigger will snap a picture of whatever is currently in front of the camera. Use this if the existing image in the dialog is not ideal.

2. Use the arrow buttons to move the blue lines for Cap Corner, Mid Cap, & Mid Neck. The Cap Corner, the vertical blue bar, should be positioned inside from the edge of the neck, not directly on the edge. The Height Search Bar, the gray dashed line, should be positioned so that all bottles fall below it. Press the Teach button. The end result is to show the right and left bottle lip clearly in the Learned Lip Pattern window. If this looks good, you may press the OK button and the setup is finished.

3. Move the Middle of Cap bar up or down with the buttons. Choose a spot in the middle of the cap. The Vision System uses this point to track the vertical position of the bottle.

4. Move the Middle of Neck bar up or down with the buttons. Choose a spot in the middle of the neck just below the bottle flange. The Vision System uses this point to find the bottom of the flange.

5. Set the limits. The first three values are the Height distances from the top of the cap to the flange. In most cases, the Min can be left at 0. Initially, Max should be set at 5-7 values over the average real-time value. The average real-time value is shown in the results windows. The fourth limit, Cocked Cap, is the difference between the highest and lowest pixel (Y coordinate on top of the cap for Cam 2 and Cam 3). This should be set around 4.
4. OPERATION

Figure 4-5: Step 4 Screen Example
Step 5 - Tamperband Inspection

Select the Tamper band inspection configuration by touching one either Tamperband Surface or Tamperband Edges in the Inspection List.

1. One the Config tab, select the type of inspection needed for this cap.

2. Select the Front tab. Move the Tamperband Location by adjusting offset. Use the buttons; up, down, left, or right. Place the left rectangle just inside of the left side of the cap where the tamper band starts (Figure 7). If the height inspections are configured correctly, the Tamper band width and right will be adjusted correctly. Because the cap is symmetrical, the software will know the proper position for the right side rectangle without operator input.

Note: Thresholds are gray scale value (0-255). As an example, 150 means that any pixel found in the search box that is below 150 is counted as dark. All values above 150 are counted as light. If the system is set to search for light and all pixels are darker than 150 there will be a zero in the results window. If the system is set to search for dark and all pixels are darker than 150 there will be a very high number in the results window.

3. Adjust the Threshold using the arrow controls. The value that results is the number of white pixels above the threshold (Figure 4-6). If the tamper band was incomplete, missing a section, or down, there would be a much greater number of white pixels that normally would have been black. The threshold may be defined and modified; light or dark (Figure 4-7).

4. Select the Rear tab, to enable the rear tamper band inspection, under Enable Surface, check Cam 2 and/or Cam 3. Select a camera and use the up and down arrows to position the tamper band in the rear windows. The Left and Right buttons allow for the entire search area to be shifted. This may be required in case the search area needs to be moved further from the edge of the cap. The All Together controls allows the individual segments to be made taller, wider, moved up, or moved down together.

5. Use Rear Camera Search Windows, indicated by the box boxes, determine where the system searches for the edge of the cap. In camera 2, the search begins on the right side of the box. In camera 3, the search begins on the left side of the box. Adjust those boxes so that the cap edge always appears in that window.

6. The Tamperband Surface limit applies to the inspection done by the two rear cameras, and the inner search box of the front camera. The average value entered from this inspection should be used as a base line. To prevent false alarms, the minimum and maximum should be set far above and below this value.
4. OPERATION

7. **Tamper band Edges** limit should be set at least 20 values above the actual. The tamper band search box grows or shrinks automatically, depending on the diameter of the cap.

*Note:* The images should be updating to see modifications in the tamper band. Keep running sample bottles through the system to see updates or use **Timed Trigger**. If the position of the green boxes for rear tamper band doesn’t update when the arrows are adjusted, verify that a camera is selected. The Step control in the bottom left corner of the page controls how much the arrow buttons change the values.

![Threshold Adjustment](image)

*Figure 4-6: Threshold Adjustment*
4. OPERATION

**Figure 4-7:** Light and Dark Threshold Settings

**Figure 4-8:** Threshold Inspection Either Black or White Selection
4. OPERATION

Step 6 - Color and Low Fill Configuration

Start the Color and Low Fill configuration by touching the box in the Inspection List.

1. Place the Low Fill rectangle (blue box) anywhere on the filled area of the bottle. The Fill Level is an average gray scale value of all the pixels in the rectangular search area. As fluid in the jar will have a lower number (darker color) than a clear bottle, the maximum limit should be set 30 or higher values above the actual.

2. Place Color box anywhere on the cap above the tamperband.

3. Press the Teach Color button. The color swatch is displayed in the Color box.

4. The Limit for color is based on the color that was taught

Note: The Step control in the bottom left corner of the page controls how much the arrow buttons change the values.

Figure 4-9: Color and Low Fill Configuration Page
4. OPERATION

4.1.2 Blowoff Set-Up

The Blowoff feature can be adjusted via the Blowoff dialog box (Figure 4-10). Bottles are tracked by the PLC using the encoder pulses between the camera and the Blowoff mechanism. Once the PLC knows the distance in encoder pulses, it can reliably kick off a bad bottle. This value is entered by choosing the main menu item, Blowoff, and changing the value Distance to Blowoff.

The amount of time the eject arm stays out can be adjusted by changing the Blowoff Duration value. Both values can be adjusted while the application is running using trial and error.

![Figure 4-10: Blowoff Set-Up Page](image)

Figure 4-10: Blowoff Set-Up Page
5. EXTENDED OPERATION

5.1 Extended Operation

5.1.1 Understanding the Diagnostic Menu

The diagnostic menu houses four options;
Recall Defective Pics, Serial Diagnostics, Align Cameras, and Shift Cameras.

Recalling Defective Pictures

The Vision system saves every defective picture to memory. To conserve space, only the last 512 pictures are stored. The Recall dialog box can be accessed by touching the Diagnostics button (Figure 5-1). Each picture displayed in the list is time-stamped. Clicking on a picture lists all of the inspections where it failed.

*Figure 5-1: Diagnostic Menu*
5. EXTENDED OPERATION

Align Camera

This tool helps align each camera in its frame. It exists to guide the Silgan Technicians assembling the cameras in the box (Figure 5-2).

Figure 5-2: Align Camera
5. EXTENDED OPERATION

Shift Cameras

This option helps control certain camera specific functions like Bandwidth, Shutter Speed, and the Vertical Image Offset. These values should not be changed by anyone, except a certified Silgan technician. These are all global settings. If any settings are adjusted improperly, they can affect the performance of the vision system (Figure 5-3).

![Silgan Vision](image)

*Figure 5-3: Shift Cameras*
6. SECURITY

6.1 Security

There are three levels of security within the system. Each has a different level of access to the functions. Access to each level can be locked separately.

Level One - Master: With a password obtained from a Silgan Field Engineer, all the other passwords can be set. A new system comes with the passwords preset (Figure 6-1). This master password accesses all levels.

Level Two - Supervisor: This level allows access to modify runtime parameters, limits, and change jobs.

Level Three - Operator: Operators can only change jobs.

For more information regarding security level access, review the Access List (Table 6-2).

Figure 6-1: Login Page
### 6. SECURITY

<table>
<thead>
<tr>
<th>Access for:</th>
<th>Operator</th>
<th></th>
<th></th>
<th>Supervisor</th>
<th></th>
<th></th>
<th>Manager</th>
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<th></th>
</tr>
</thead>
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<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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*Table 6-2: List of Security Options for Each Level of Access*
## 7. TROUBLESHOOTING

### 7.1 Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The monitor shows a blank screen.</td>
<td>No power. There is a bad connection in the monitor cables. The monitor is bad.</td>
<td>Check the main circuit breaker. Check the connections for the monitor cable from the monitor to the video connection of the computer. Check for 120 VAC at the power connection to the monitor.</td>
</tr>
<tr>
<td>No mouse on the touch screen.</td>
<td>There is a bad connection between the USB port and the monitor. Driver setup has been lost.</td>
<td>Check the connections between the USB port and the monitor. Run the c:\programfiles\Elo\ELOVA.EXE diagnostic program and follow instruction.</td>
</tr>
<tr>
<td>Cordless mouse and keyboard do not work.</td>
<td>Batteries are dead. There is a bad connection.</td>
<td>Check the batteries. Check the transmitter/receiver connection to the USB port. Reinitialize the keyboard or mouse by pressing the button on transmitter/receiver and then on bottom of keyboard or mouse.</td>
</tr>
<tr>
<td>The strobe lights do not fire.</td>
<td>The fuse for the strobe is blown. There is a bad connection in the strobe cables.</td>
<td>Check the 24 VDC fuse #F2. If bad, replace. Check the connections at the strobe I/O module.</td>
</tr>
<tr>
<td>The image of the bottle is out of focus.</td>
<td>There are water spots or other debris on the camera windows.</td>
<td>Use a lint free cloth to wipe any water spots off the glass located inside the channel that the bottles pass through.</td>
</tr>
<tr>
<td>Images are not being acquired.</td>
<td>The bottles are not triggering the photo eye.</td>
<td>Make sure that foreign objects or debris are not obstructing the photo eye through beam. Make sure that the height of the machine allows the bottles to break the photo eye through beam when they pass in front of the bulkhead.</td>
</tr>
</tbody>
</table>

*Table 7-1: Troubleshooting Table*
8. TECHNICAL ASSISTANCE

8.1 Technical Assistance

For assistance in resolving issues not addressed by this manual, please contact your Silgan Field Service Engineer.

Should your Silgan Field Service Engineer be unavailable, call Silgan Equipment Company Customer Service at 847-336-0552. Your case will be directed to the next available Service Engineer.

For repair and replacement parts, call Silgan Equipment Company Customer Service at 847-336-0552.

For Technical Support, Call: 877.205.3225
www.silganequipment.com/vision/
Waukegan, IL USA