Getting Started:

This 30-minute tutorial is intended to introduce you to the basic functionality of GRIMe. Upon completion, you should be able to use GRIMe to detect water level using images you have stored on your computer.

Step 1 – Acquire Images

For demonstration purposes, we will use a simple image with a well-defined edge. As with most machine vision applications, the quality and reliability of edge detection will depend on the quality of the images. The GRIMe installer has stored the sample images in a directory on our hard drive (C:\Program Files/GaugeCam/docs).

Step 2 – Load Images

On the PROCESS TAB click *Camera Folder* and browse to the directory where the images are stored (C:\Program Files/GaugeCam/docs). Image thumbnails will not be visible in the dialog box, as you are only choosing a directory. Click Choose. A list of the sample images will appear in the PROCESS TAB window. Click on any of the listed images to load that image in the image window.

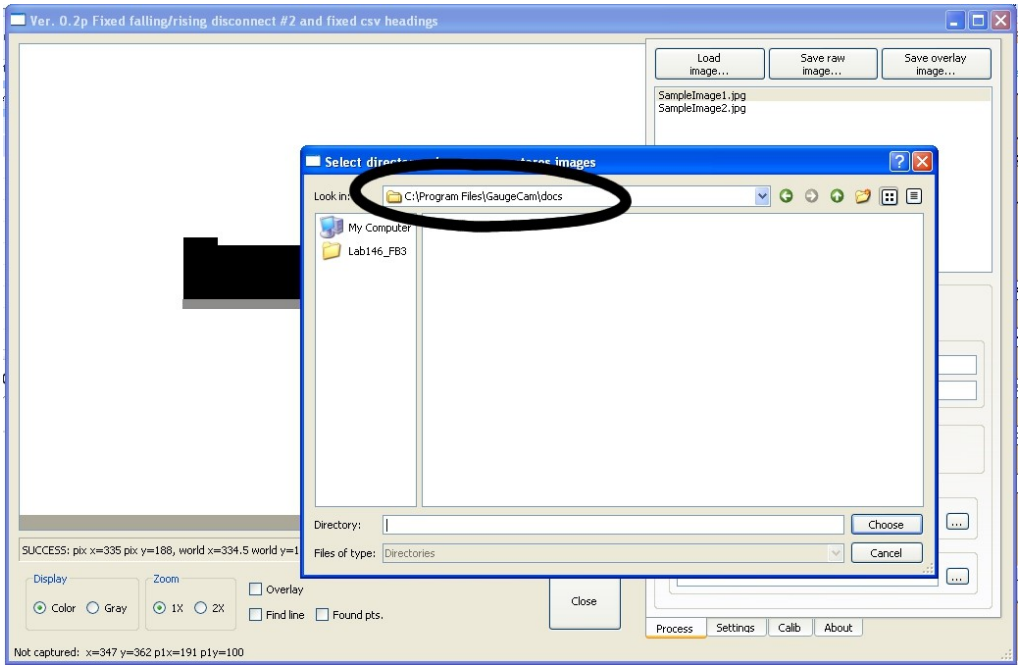

Figure 1: Loading image directory

Step 3 – Set Search Area

Click on SampleImage1 to load the image. Double-click on the image. A green search line and a red search line will appear on the image. Note the circular shape on one end of each search line. Click and drag the search lines, one on each side of the edge you want to detect. Set the search lines as seen in Figure 2.

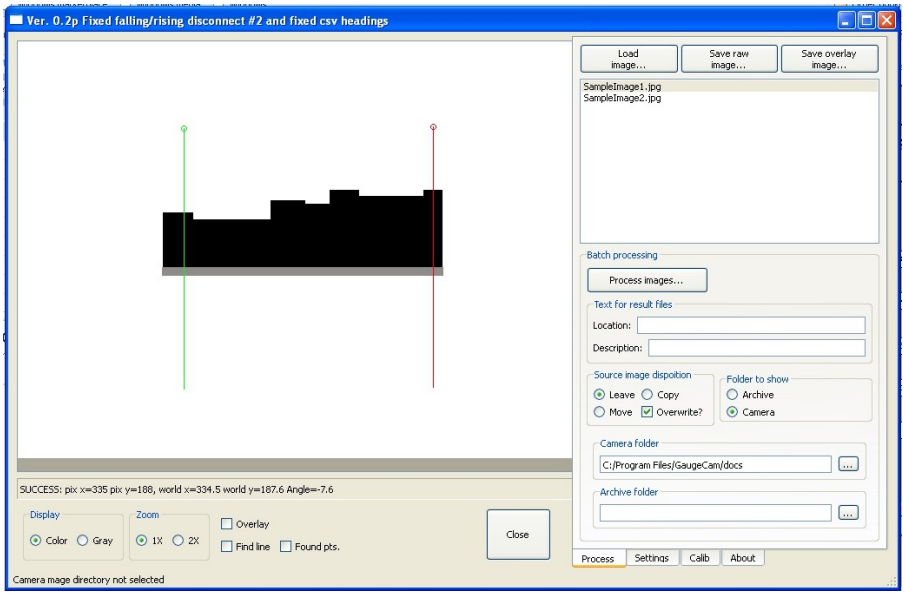

Figure 2: Positioning search lines

Step 4 – Investigate Edge Parameter Settings

Click on the SETTINGS TAB. You will see several settings that are available for processing images. In this step, we will perform a preliminary investigation of the image to determine appropriate settings for *Threshold, Kernel, Edge Polarity, Min%,* and *Which* Edge. Double-click the image again. The search lines will disappear. Place the cursor near the edge you wish to detect. Click and hold as you move the cursor across the edge. GRIMe displays the pixel location and grayscale value, as shown in Figure 3.

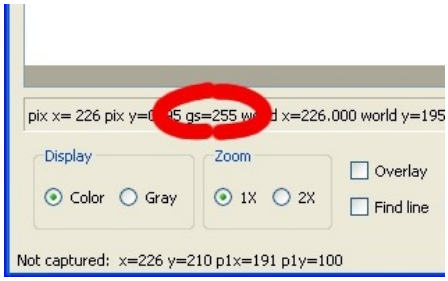

Figure 3: Investigating grayscale

Estimate the *Threshold* setting required for edge detection by noting the grayscale values above and

below the edge and subtracting to find the difference. In this case the grayscale above the edge is 255 and the grayscale below the edge is zero. As a result, setting threshold as high as 255 should result in succesful edge detection.

The ideal *Kernel* setting can be estimated by visually determining if the edge is very sharp (small kernel) or fuzzy (large kernel).

The *Edge Polarity* setting is typically set relative to the location of the circular ends of the search lines. For example, if the circular ends are located on the "light" side of the edge, the resulting edge will typically be detected as the light-colored pixels transition to dark-colored pixels, which is a Falling Edge.

Min% sets the minimum percentage of pixel columns which must contain an edge point. If the *Min%* setting is met, then a linear regression of the edge points is used to determine the edge detection location. Since SampleImage1 contains a well-defined edge, *Min%* may be set near 100. For images with less-defined edges, a lower *Min%* may be desirable.

The *Which Edge* setting is typically left as First. However, a setting of Max may be desirable for less-defined edges.

Step 5 – Set Edge Detection Parameters

In the **SETTINGS TAB**, choose the following settings:
Threshold: 100
Kernel: 5
Min %: 90
Edge Polarity: Falling
Which Edge: First

Click *Save Settings.* Choose a file name and location. We will load these again settings later.

Step 6 – Activate Edge Detection and Overlays

Below the image window are three check boxes, *Show Overlay*, *Find Line*, *Found Points*. Select *Find Line* and *Show Overlay*. An edge line will appear. Select *Found Points* and individual edge points will be highlighted. The edge line is a linear regression of the highlighted edge points.

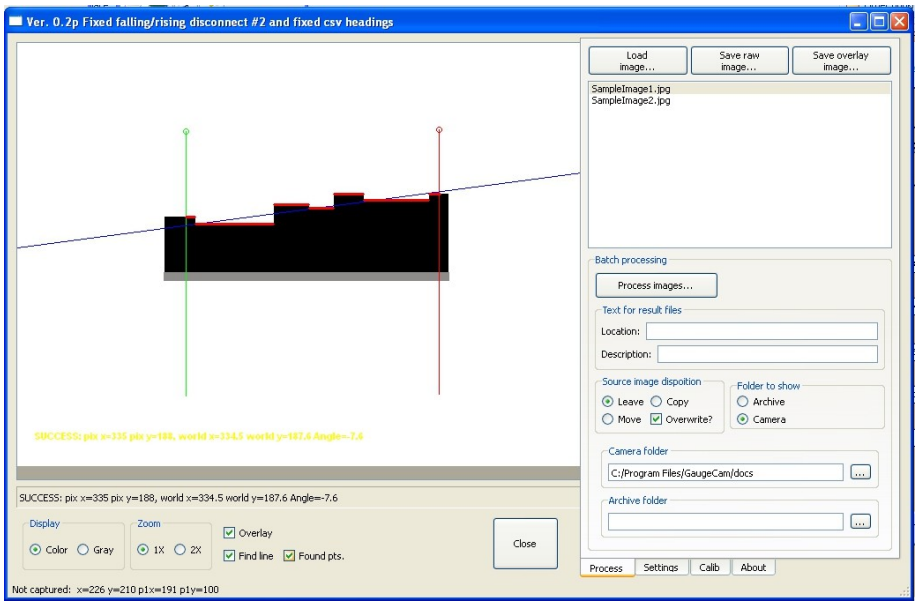

Figure 4: Found line overlays

Step 7 – Experiment with *Edge Line Settings*

Adjust Threshold, then Kernel and then Min%. Note the effects on the location of the edge line. Change Edge Polarity to Rising. The edge line is now found on the lower edge of the object in SampleImage1, which is an edge that transitions from dark to light.

Click *Load Settings.* Load settings saved in Step 5.

Step 8 – Activate *Outlier Removal*

On **SETTINGS TAB**, enable Outlier Removal. Set Passes to 3. Set Max Pt Distance to 6.00. With each pass, the outermost edge points will be removed. In addition, any edge points further than 6.00 points from the Edge Line (linear regression line) are removed from the data set. The Edge Line is recalculated after each pass. Raise Passes to 5. A failure message will appear on the image and on the lower left corner of the program window. In the far left lower corner you should see a message stating "FAIL: Insufficient found point count percentage". Lower Passes back to 3 and the line should reappear. Disable Outlier Removal.

Step 9 – Activate *Angle Restriction*

The Edge line angle is displayed in the lower left corner of the image window when *Show Overlay* is activated. On **SETTINGS TAB**, enter an angle value of 0.00 in the Nominal text box. Adjust the +/- value to 7.00. Click enable. The edge line overlay is removed and an error message, "FAIL: Bad angle find," appears in the lower left corner of the image window. Now raise the +/- to 10.00. The found line should reappear. Note the approximate angle value of the found line displayed in the lower left corner of the image window. Enter this value (-8.60) in the Nominal text box. Now you can lower the +/- value as low as 1.00 without the edge line overlay being removed. The Nominal input is useful for skewed images in which a horizontal water line actually appears at a nominal angle in the image.

Step 10 – Reverse Search Lines

On **SETTINGS TAB** disable Angle Restriction and Outlier Removal. Reverse the red and green search lines as shown in the image below. The circular ends of the search lines should now be toward the bottom of the image. Note the location of the edge line. Change *Edge Polarity* to Falling. Note the new location of the edge line.

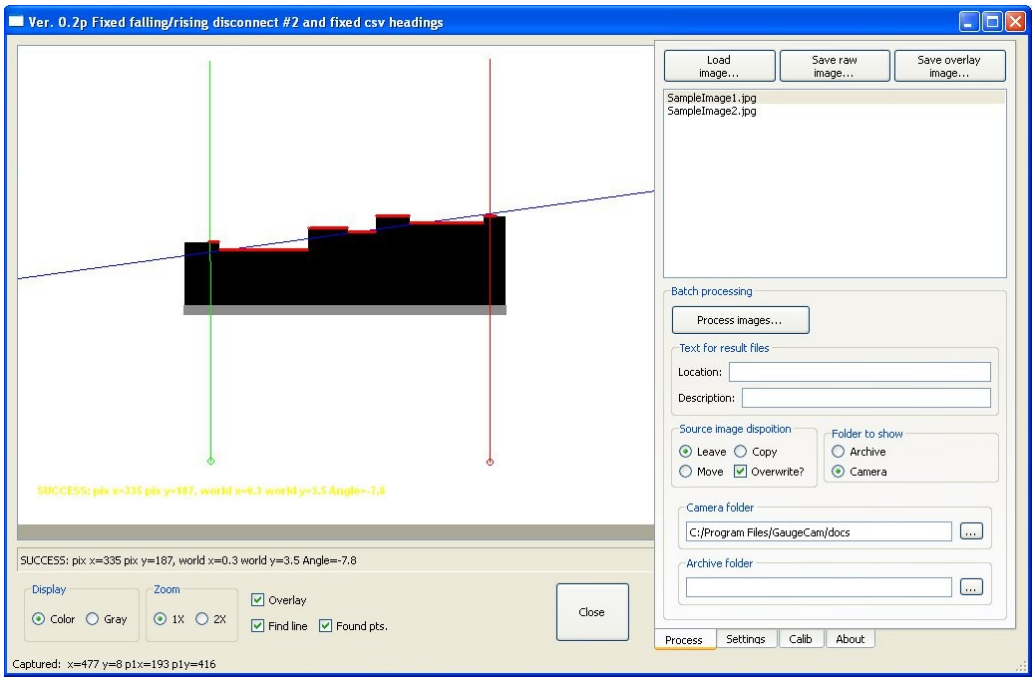

Figure 5 : Reverse search lines

Step 11 – Manual Calibration

Click on the CALIB TAB. At the top of the tab click *Load.* Browse to and select "SampleCalibration.cal" in order to load the sample calibration grid.

Right-click in the image window. Choose Show calib ROI, as seen in Figure 6.

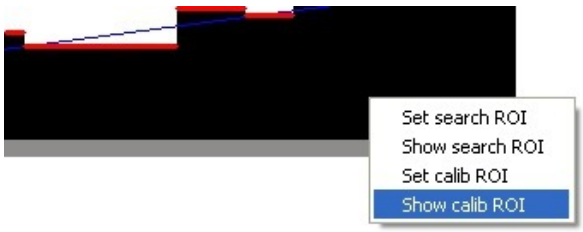

Figure 6: Show calibration region of interest (ROI)

The calibration grid appears, as seen in Figure 8. To calibrate a real-world image, you would click on grid intersections and drag to known points in the real world, as depicted in Figure 7. For this tutorial, we will only adjust the real-world calibration values.

Figure 7: Example of Real-world calibration grid

Double-click on the lower left node. A text box appears, as seen in Figure 8. Enter the real-world coordinates (0,0). Assume each node is a distance of one unit from the closest node. For example, the lowest, center node has coordinates of (1,0). The node just above it has coordinates (1,1). The upper right hand corner node has coordinates of (2,6). When node coordinates have been entered, real-world to pixel calibration is complete. You may confirm your calibration settings by viewing the **CALIB TAB**. Note the pixel and real-world coordinates are also provided for each found edge line in the lower left corner of the image window.

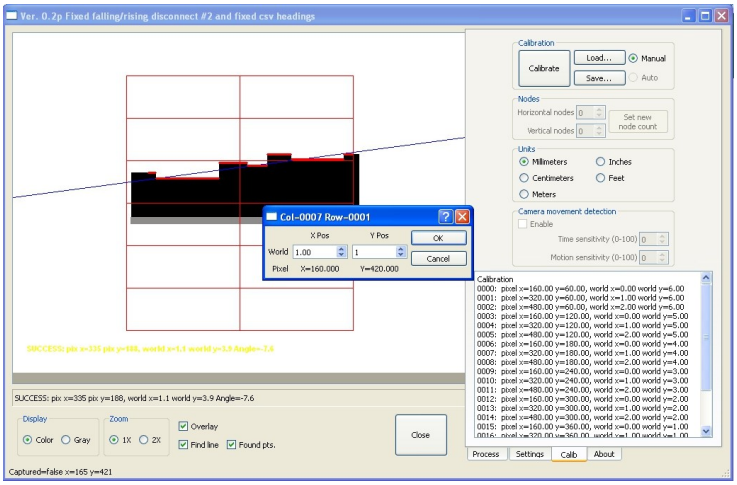

Figure 8: Calibration grid and settings

Step 12 – Batch Processing

In the **PROCESS TAB**, enter “SampleImage1” in the Description text box. Enter “Test1” in the “Location” text box. To process all images shown click *Process Images*. Choose a file name and location for the results file. Click Open and the images will be processed. A .csv file containing the line find results can be found in the location you indicated in the dialog box.

Congratulations, you have completed the GRIMe tutorial!