Documentation for auto foil kinematics vi

Brief description:

The auto foil kinematics vi reads in a 1024x1024 AVI video of the foil in motion, and in each frame, digitizes the surface of the foil as a series of points, fits a spline to these points, and saves the spline plot as a frame in an avi. From each motion cycle, 24 equally spaced (temporally) splines are saved in a txt file for use in kinematics snapshots graphics (see below). In addition, for each motion cycle, the amplitude of oscillation at 13 points along the foil, are saved to text files (see below). The user also has the option of saving the raw detected surfaces and additional splines to txt files.

Optionally, the vi can find two segments of a foil instead of one body, such as in the case where there is a body and tail with a gap between.

*Snapshot graphics can be generated using iPython notebook (Foil_Snapshots_Generator.ipynb). This notebook reads in the txt files and plots the splines in different colors on the same chart, forming a snapshot graphic. Either 4 or 6 evenly spaced (temporally) splines can be plotted for a whole or half motion cycle.

*Amplitude of oscillation txt files can be plotted using iPython notebook (Foil_AmpOscillation_barchartgenerator.ipynb). This notebook reads in the txt files, finds the mean and standard error of amplitude of oscillation at each position along the foil, and plots the results as a bar chart. Multiple foils can be plotted on the same chart.

*Spline fit can be verified by plotting the spline on top of the original image using Matlab (check_spline_fit.m). This reads in the “extra splines (at increment)” txt file and the original foil avi and plots the spline on top of the movie frame.

History:

v4.1 - Aug 1, 2016
-Removed excess unused displays.

v4.0 - May 21, 2016
-Added new feature allowing the user to toggle on a mode that detects two separated segments of a single foil (such as a foil with a body and tail, with a visible gap between). Modified all output options to handle this accordingly.

v3.4 - July 24, 2014

-Fixed a minor bug in the Start Frame functionality. In previous versions, using a start frame other than 1 caused an error in the way detected surfaces were stored in memory - the first surface would be stored in an array at column 2*frame#, rather than at column 0.

v3.3 - May 19, 2014
-Added a option to set the starting frame
-Fixed a bug in the surface offset feature. In previous versions, adding an offset caused errors in the zero filter.

v3.2 - May 16, 2014
-Fixed a bug in the kinematics AVI animation. In previous versions, the spline was plotted in a mirror image from the original movie frame.

v3.1 - May 14, 2014
-Fixed a label on the front panel. The user input of foil length is now labeled “Foil chord (m).” In previous versions, this incorrectly read “Foil span (m).”
-Fixed a bug in the extra spline saver. In previous versions, the y-data of the last spline would be cut off if the number of splines saved out was odd.
-Added a rod simulator (optional). In previous versions, if the rod was too dim or was cut out of analysis using the pixel column start index, the rod was neglected during spline fitting and subsequent analyses. This resulted in incorrect values for amplitude of oscillation.

v3.0 - May 7, 2014
-Fixed a bug in detection of drifting trailing edges. In previous versions, the Matlab functions for creating splines required that the foil was always a set number of pixels long. For highly curved foils (a very flexible foil), this is not necessarily the case. Spline fitting now occurs during each frame rather than on collected data at the end. This yields a matrix with constant row and column lengths appropriate for further analyses.
-Fixed a bug in the foil surface detection for where the image filtering functionality is used in place of max pixel. In previous versions, In the test space, the detected y-coordinate went to -1 instead of 0 where no surface was detected.
-Added image rotation/mirroring options to align the foil correctly (leading edge left) and removed the less capable transpose image switch
-Made every file save optional
-Made red & black “test display” (displays detected foil) optional
-Corrected the x-axis label on “pixel column intensity” figure to “y-position.” This label read “x-position” in previous versions.
-Fixed a bug in the axis max limits in the Matlab kinematics AVI animations. In previous versions, the value defaulted to 325x325 mm, which might not capture the foil if the image had other dimensions
-Added a frame increment to kinematics AVI writer to speed up playback and reduce file sizes
-Fixed a bug that kept previously saved kinematics AVIs in memory and inserted them into the current analysis.

-Added an option to export raw detected surfaces in either pixels or mm.

v2.0 - Apr 10, 2014
-Fixed a bug in the amplitude of oscillation extractor. In previous versions, the extractor found the max and min y-values for the foil from the subset of splines saved out. In this version, this was fixed so that the max and min y-values came from all of the splines (as in, finding the max and min by looking at all the video frames, not a subset of them)
-Added a on/off switch to the splines subset saver (now called "extra kinematics splines")
-Added a spline saver for use with generating snapshots. This saver differs from the previous because it is always on and it only saves 24 evenly spaced (temporally) splines from each motion cycle. The resulting txt file can be taken into other programs to create snapshot graphics.

v1.3 - Feb 28, 2014
-Updated amplitude of oscillation extractor to analyze each motion cycle individually (requires new "number of cycles" control on the front panel)
-Added cycle number labels to the amplitude of oscillation data table exported as a txt file
-On the block diagram, added labels to arrays in the spline generator/saver and amplitude of oscillation functions

v1.2 - Jan 22, 2014
-Updated amplitude of oscillation extractor to export column titles along with data
-Updated amplitude of oscillation extractor to include amplitude normalized by body length (requires the new foil span control on the front panel)
-Eliminated DaVis scaling on/off switch so that the surface finder always exports data in mm in order to support Matlab script node function (node defines axes' max/min during execution, but numbers were only reflecting mm, not pixels)
-Eliminated unused indicators on the front panel for clarity (object, surface as points, first edge pixel, threshold used)

v1.1 - Dec 19, 2013
-Added amplitude of oscillation extractor
-Removed "y-value for none found" feature from front panel and set the value to 0 from the block diagram for Matlab script compatibility
-Changed "surface" chart axes on the front panel from units of mm to units of pixels for clarity during initial set-up procedures
-Removed unused commented-out lines from Matlab script node
-Changed contents of Matlab script node to generate splines off of 204 points instead of 200 to support amplitude of oscillation extractor function

v1.0 - Dec 18, 2013
-Original surface finder from Erik Anderson plus Kelsey Lucas's spline generator/saver functions.

Detailed description:

The auto foil kinematics vi reads in 1024x1024 AVI files of foil motion and begins by detecting the foil, one frame at a time. For each frame, the image is displayed at the top right of the front panel, and analyzed below. The image is first thresholded; the pixels that have an intensity value within the range specified in the Range block on the front panel (see Settings section) are kept, and the rest are thrown out. This saves only the pixels that have high enough intensity to possibly be the foil. The remaining pixels are searched based on the criteria in the Selection Values block on the front panel (see Settings section), and only pixels with an area within the specified range are kept.

Next, the vi runs an edge finder search to quantify the position of the foil. LabView will analyze one column of pixels at a time (starting and stopping columns are set by the user; see Instructions step 16-18 and the Settings section). The vi will run down each column, reading the pixel intensities. If no edge is found in a column, the vi notes the edge value for that column as y=0.

One of two means are used to identify the edge, depending on the "use max pixel for surface" switch. When this switch is ON (default), LabView reads the as a single pixel. It does this by saving the largest pixel and blacking everything else out. This works because because the foil is a continuous object and is the largest object in the field of view. ***Note that errors will occur if the foil is not the largest, brightest object in view.*** Then, the vi goes through the pixel columns, reads the pixel intensities in each column, and finds where the pixels transition from black to white. The y-values where this transition first occurs are saved as the foil location. An offset value can be added into the y-values to account for foil thickness (ex: foil is 4 pixels thick, use offset of 2 to get the midline).

If the "use max pixel for surface" switch is OFF (only in instances where the foil is not the brightest object), the vi will search that column for a bright patch with an expected width (width of the foil). Because the foil has glare (ramping up intensity as approach the foil) and thickness (a stretch of same-value, high-intensity pixels), the program identifies the edge of the foil by determining where the pixel intensity stops ramping up and starts to plateau. This location (y-value) is noted, along with the column number (x-value). Again, an offset value can be added into the y-values to account for foil thickness.

Thus, a list of points denoting edge position is generated. The user can turn on a switch that saves out this raw surface data in either pixels or mm. Then, this list is filtered, eliminating the zeros.

The rod can optionally be simulated at this point. If the rod was too dim for detection or if the rod was excluded from detection, a line with length equal to the rod's is extended from the foil's leading edge. If there is pitching motion, the rod is simulated using a best fit line at the foil's leading edge. If there is no pitching motion (heave only), the rod is simulated as a horizontal line at the foil's leading edge. If the rod is not desired in analysis, or if the rod was detected along with the foil, this simulation can be turned off via a button on the front panel.

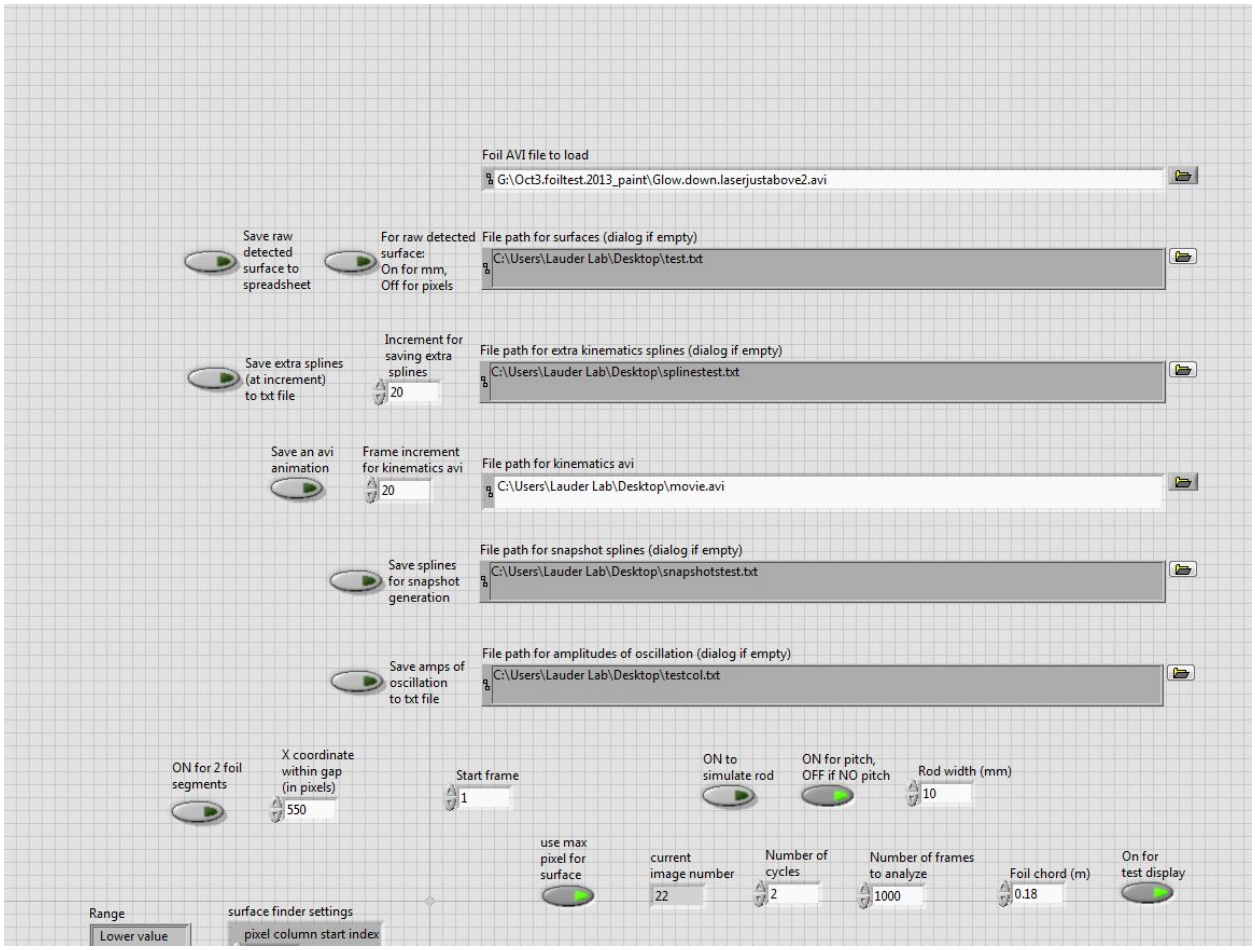
By calling Matlab, the vi then goes frame-by-frame, fitting a spline to the frame's filtered data, plotting this spline, and saving the plot as a frame in an AVI. From each motion cycle, 24 evenly spaced (over time) splines are each saved in a txt file as a list of 204 points. The resulting txt file can

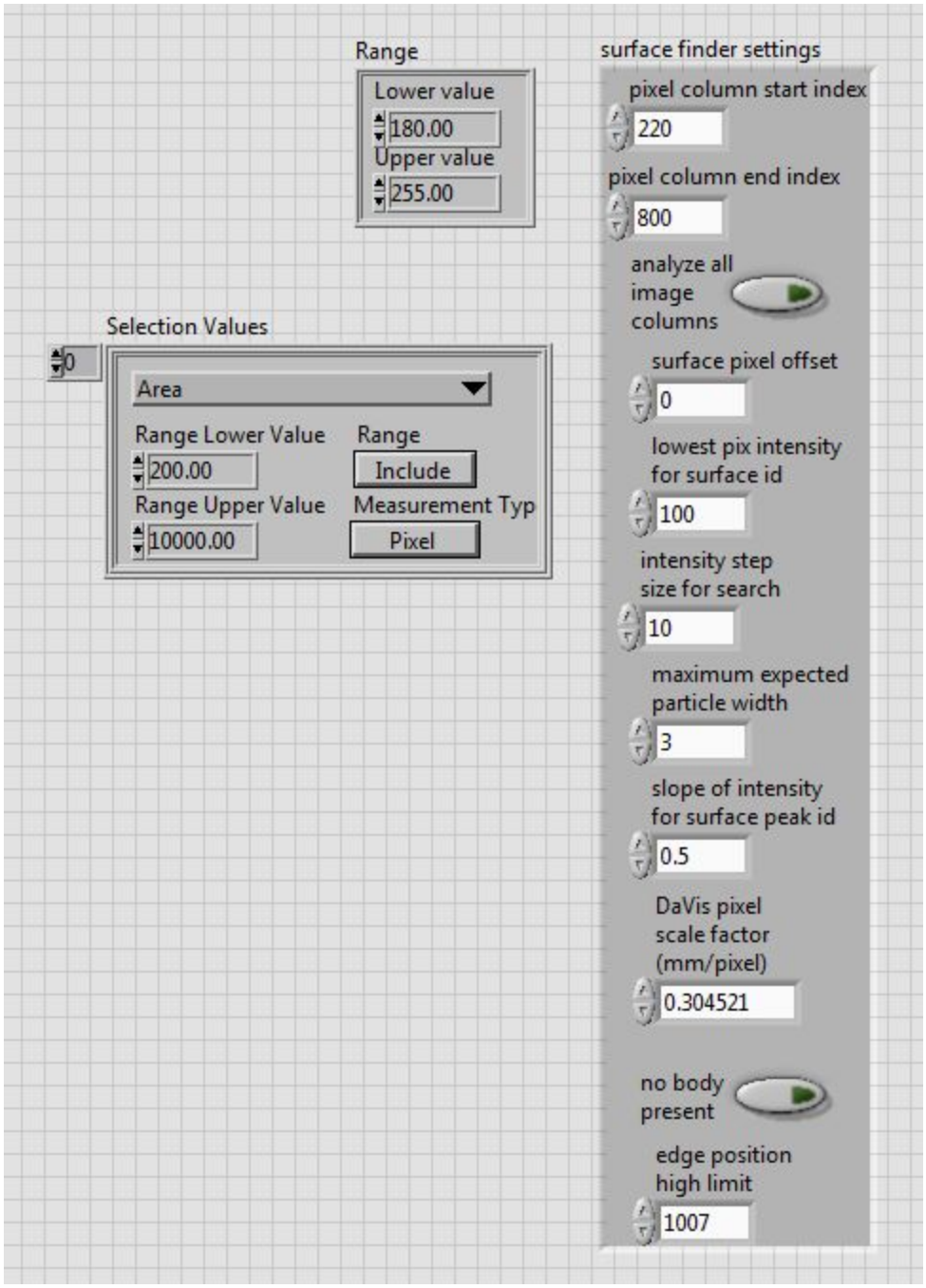
be taken into other programs to create snapshot graphics. In addition, the user can turn on a switch that causes a subset of the splines (at a user-specified increment, for example, save the spline every 20 frames) to also be exported.

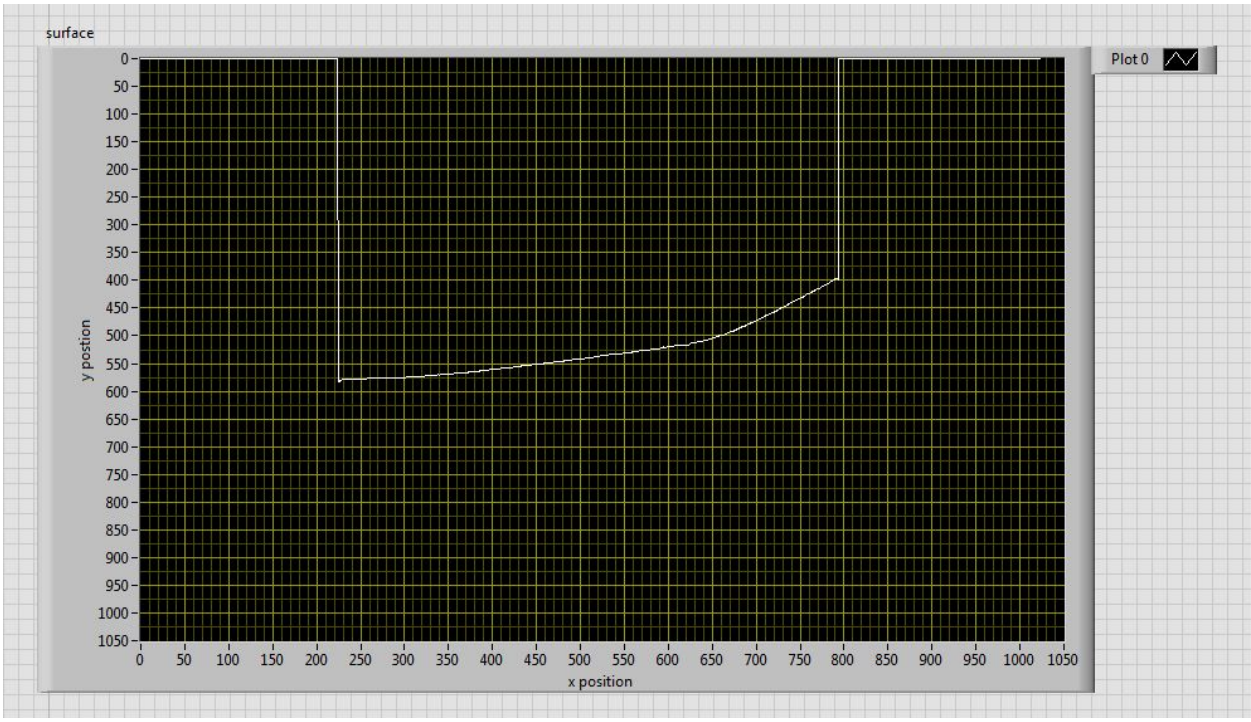
For each spline in each motion cycle, 13 points along the spline (leading edge as point zero, and then points at each 1/12th of the way along the foil, where point 13 is the trailing edge). The vi will then find the amplitude of oscillation at these 13 points along the foil by finding the maximum and minimum y-position for each point, taking the difference, and saving this value. The amplitudes of oscillation are then exported. The resulting txt file can be taken into other programs to create plots.

When the 2 Segments mode is active, the vi will use a user-supplied estimate of where the gap between foil segments is located to divide the detected data into front and back portions. The same processes detailed above are used to detect the foil segment in each section. The data is then concatenated back together to provide splines for the whole foil's length. To be compatible with kinematics processing and existing codes relying on the vi's output, the two segments are identified using a 204 points total.

Front Panel Screenshots:




Range
Lower value
180.00
Upper value
255.00
surface finder settings
pixel column start index
220
pixel column end index
800
analyze all image columns
surface pixel offset
0
lowest pix intensity for surface id
100
intensity step size for search
10
maximum expected particle width
3
slope of intensity for surface peak id
0.5
DaVis pixel scale factor (mm/pixel)
0.304521
no body present
edge position high limit
1007
Selection Values
0
Area
Range Lower Value
200.00
Range
Include
Range Upper Value
10000.00
Measurement Typ
Pixel


surface
Plot 0
y postion
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
x position

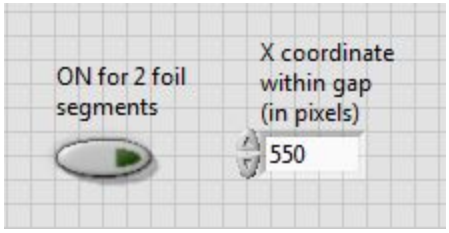
Instructions:

1. Open the auto foil kinematics vi. Do NOT close the Matlab window that also opens.

2. Set file path for the Flapper AVI file.

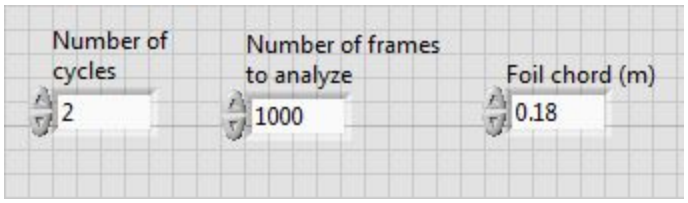
3. Specify if the video contains two separate foil segments using the "ON for 2 foil segments" button. Default is off - one complete foil body is visible. If two segments are visible, provide an x-coordinate value in pixels located inside the gap between segments.

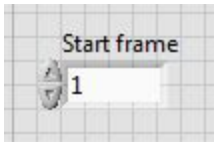
- It may be necessary to start & stop the vi to use the surface graph to identify an appropriate x-value.



4. Specify how many motion cycles the foil completes, how many frames in the Flapper AVI to analyze, and the foil's chord length. Specify the start frame. (see Setting section)

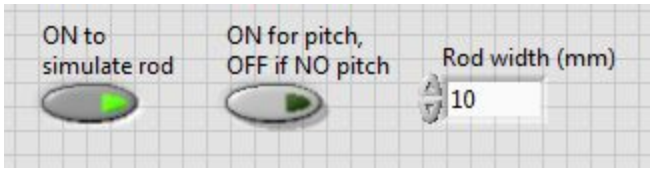
- If rod is either simulated or detected, chord length should include the part of the foil under the rod.
- If the rod is not desired during analysis, subtract the rod width from the foil's chord length, and enter the difference here.





5. Specify whether the rod will be simulated. If yes, also specify whether the foil is pitched during its motions and the rod width in mm (see Setting section).

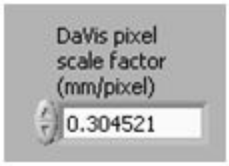
*Rod simulation is used if the rod needs to be considered as the leading edge for amplitude of oscillation, AND if the rod is too dim to be detected or if the rod will be excluded from analysis in step 20.



6. Turn the “On for test display” switch ON.

7. Enter the calibration factor from DaVis (mm/pixel) into the control. The control can both be found in the surface finder settings panel.

*Note that only exported data (both txt and AVIs) will have mm units. The surface chart on the front panel displays in pixels for setting purposes (see steps 17-20).



8. Look at the no body present switch in the surface finder settings panel.

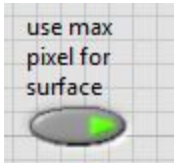
- If there is a foil in the AVI, verify that the no body present switch is OFF (default) and go to

step 9.

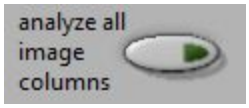
- If there is not a foil in the AVI (particle flow only), turn the no body present switch ON, adjust the Range and Selection Values settings (see Settings section) as needed, and go to step 21.

9. If the foil is the brightest object in the AVI images, verify that the use max pixel for surface switch is ON, then go to step 10. Otherwise, switch the use max pixel for surface switch OFF, and then go to step 10.

Note that errors will occur if this switch is ON and the foil is not the brightest object in view



10. Turn ON the analyze all image columns switch in the surface finder settings panel. (Note that default is OFF).



11. Verify that all the save options switches next to the file path boxes (see Front Panel Screenshots) are turned OFF (default).

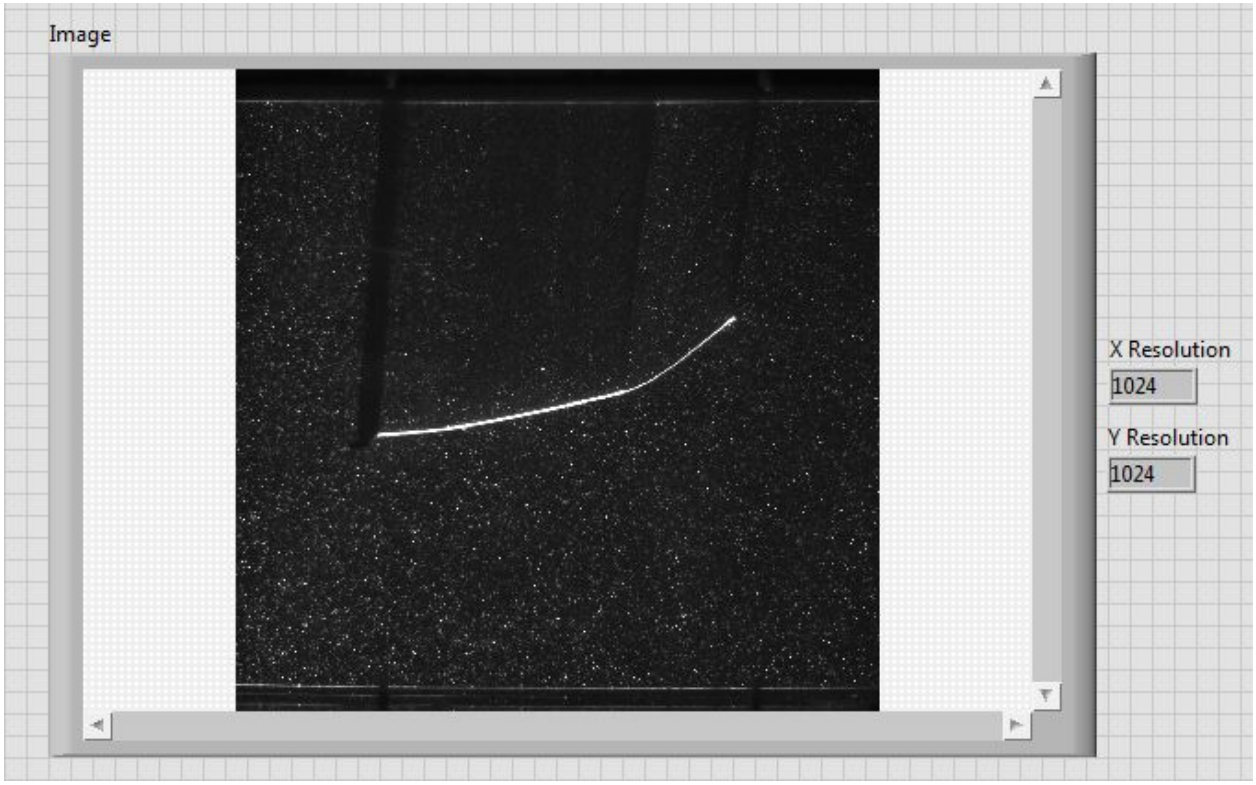
For steps 12-16, the vi will be run in short bursts in order for the detection settings values to be determined. To do this, hit run. Let the vi analyze around 20-50 frames, then hit stop. Adjust settings, then test run again. When appropriate settings are found, go to step 16 for further instructions. Please also refer to the Settings section.

If there is a part of the video where the vi has trouble identifying the foil, use the start frame control to start tests at this part of the video (ex: the vi mis-IDs the foil in frame 100. Set start frame to 90 to speed up testing).

12. On the front panel of the vi, check the image displays next to the file path boxes (see Front

Panel Screenshots).

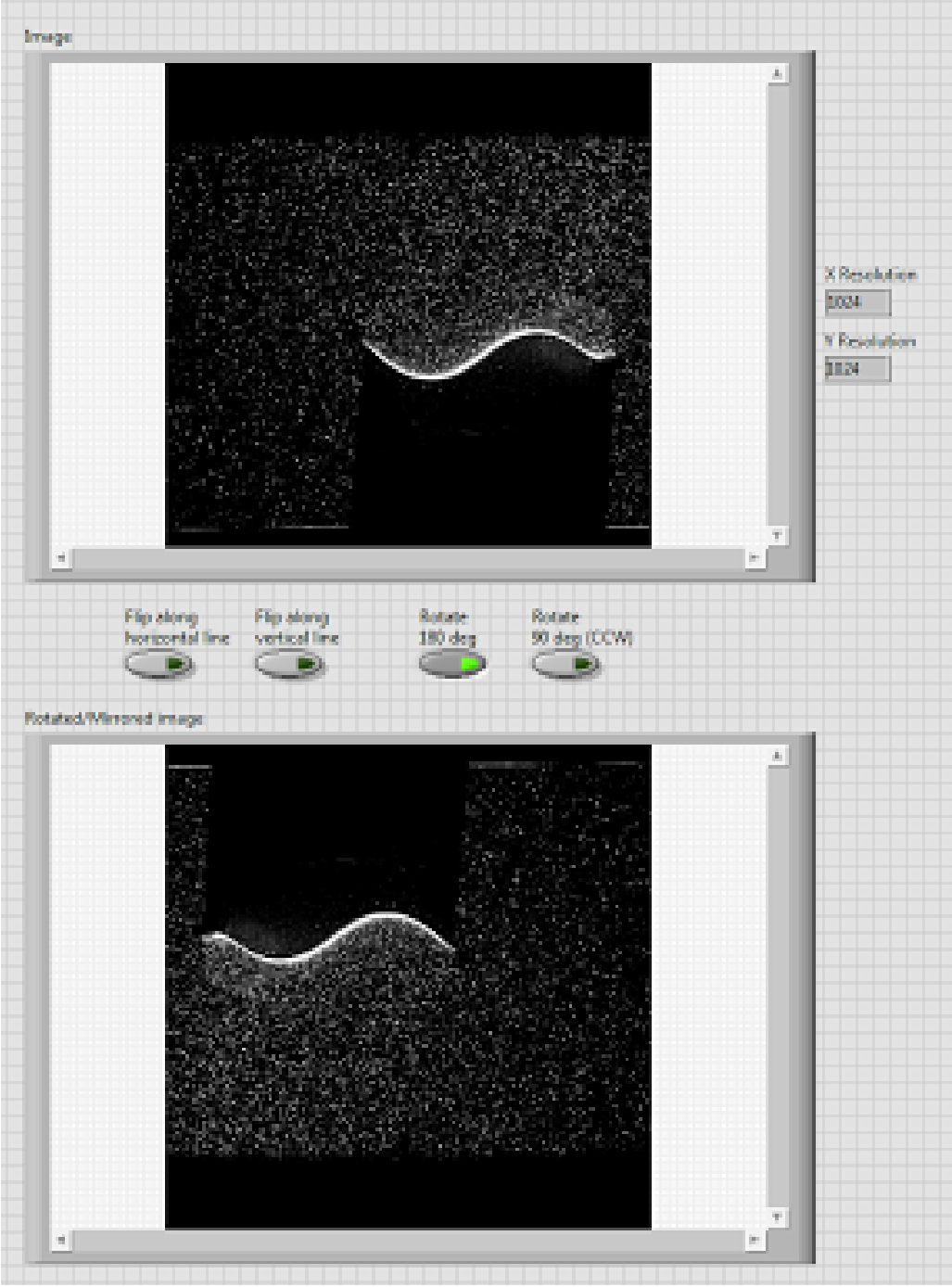
- Verify that the “Image” display is showing the Flapper AVI.
- Verify that the X and Y Resolutions are 1024.



13. Verify that the foil is swimming to the left and its “cleaner” side is on top.

- In the sample picture below, the Image display shows the original video with the foil swimming to the right. Many bright pixels are adjacent to the foil on the top side, but the bottom side has a clean surface and high contrast.
- Stop the vi, and then use the Flip and Rotate push buttons to mirror or rotate the image as needed (in sample, a 180 degree rotation was needed)
- Verify the changes by starting the vi again to get the Image displays to update.

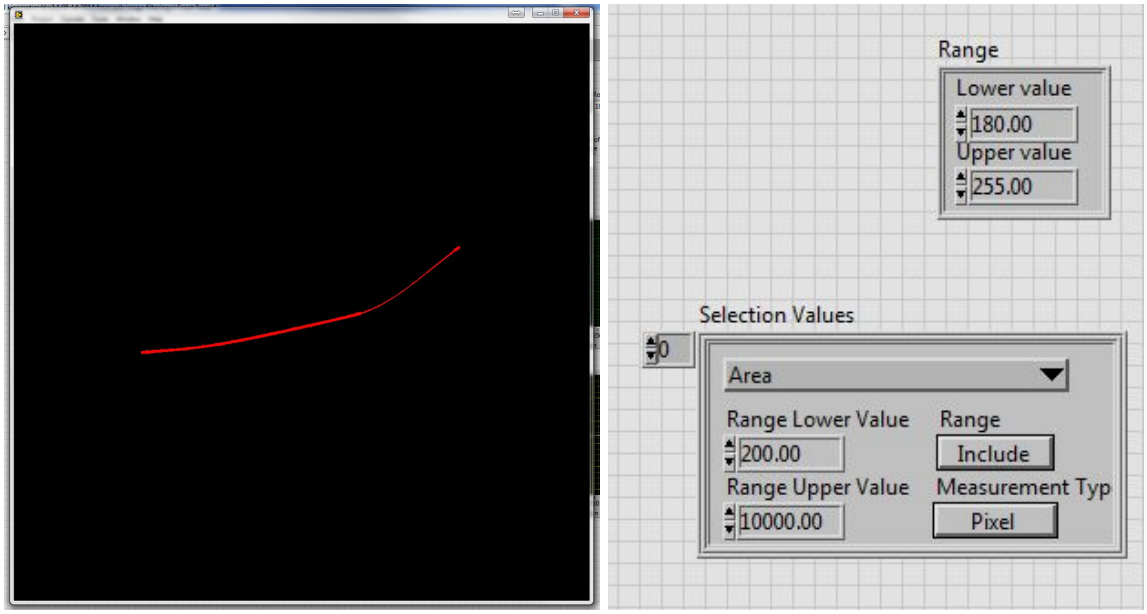
- To get specific rotations:
  - 90 degrees counterclockwise - turn Rotate 90 deg (CCW) switch on
  - 180 degrees - turn Rotate 180 deg switch on
  - 270 degrees counterclockwise (or 90 degrees clockwise) - turn on these two switches: Rotate 180 deg, Rotate 90 deg (CCW)



14. If the foil is the brightest object in the video (max pixel switch was turned ON in step 9), continue to step 15. If the max pixel switch was turned OFF in step 9, go to step 15.

15. Look at the window that pops up when the vi runs. The field should be black, with the foil as a continuous red strip. The foil (and bright pixels right alongside it) should be the only object in the field. If not, stop the vi and play with the settings. Some guidelines are below:

- If other objects are visible, increase the lower values of Range or Selection Area settings (see Settings section).
- If the foil is not visible:
  - For a foil with a short span, decrease the lower value of Selection Area.
  - For a foil with a long span, increase the upper value of Selection Area.
  - For a dim foil, turn the use max pixel for surface switch OFF and go to step 16.



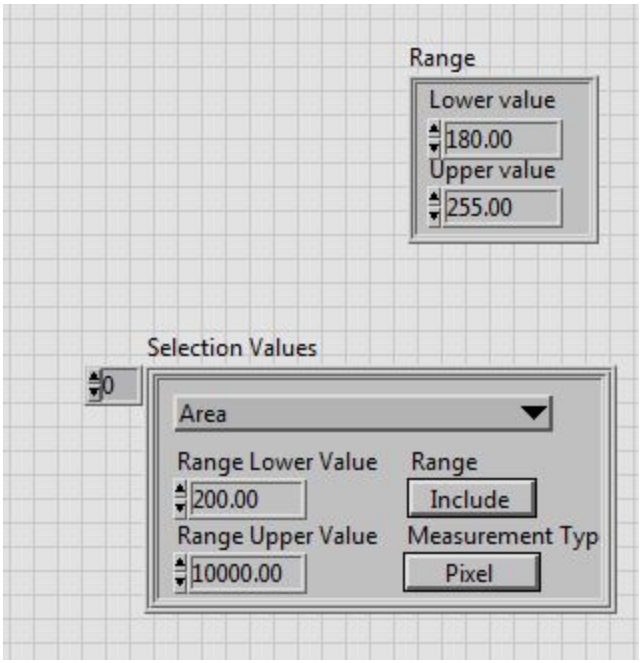
Step 16 is only for when the use max pixel for surface switch is OFF. If this switch is set to ON, skip ahead to step 17.

16. Look at the window that pops up when the vi runs. The field should be black, with the foil as a continuous red strip. The foil (and bright pixels right alongside it) should be the only object in the field (see picture in step 15). If not, stop the vi and adjust the Range, Selection Values, and four Surface Finder Settings parameters pictured below until the foil is properly detected. Some guidelines:

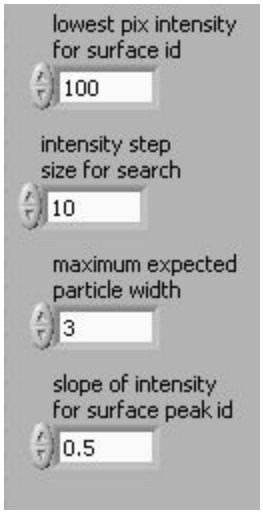
- For dim foils,
  - Decrease the lower value in Range and for “lowest pix intensity for surface id”
  - If there are pixels brighter than the foil, decrease the upper value in Range
- For thick foils, increase “maximum expected particle width”

- If the foil is not visible and you suspect it is due to its length:
  - For a foil with a short span, decrease the lower value of Selection Area.
  - For a foil with a long span, increase the upper value of Selection Area.

Range and Selection Values blocks:



Surface finder settings parameters:



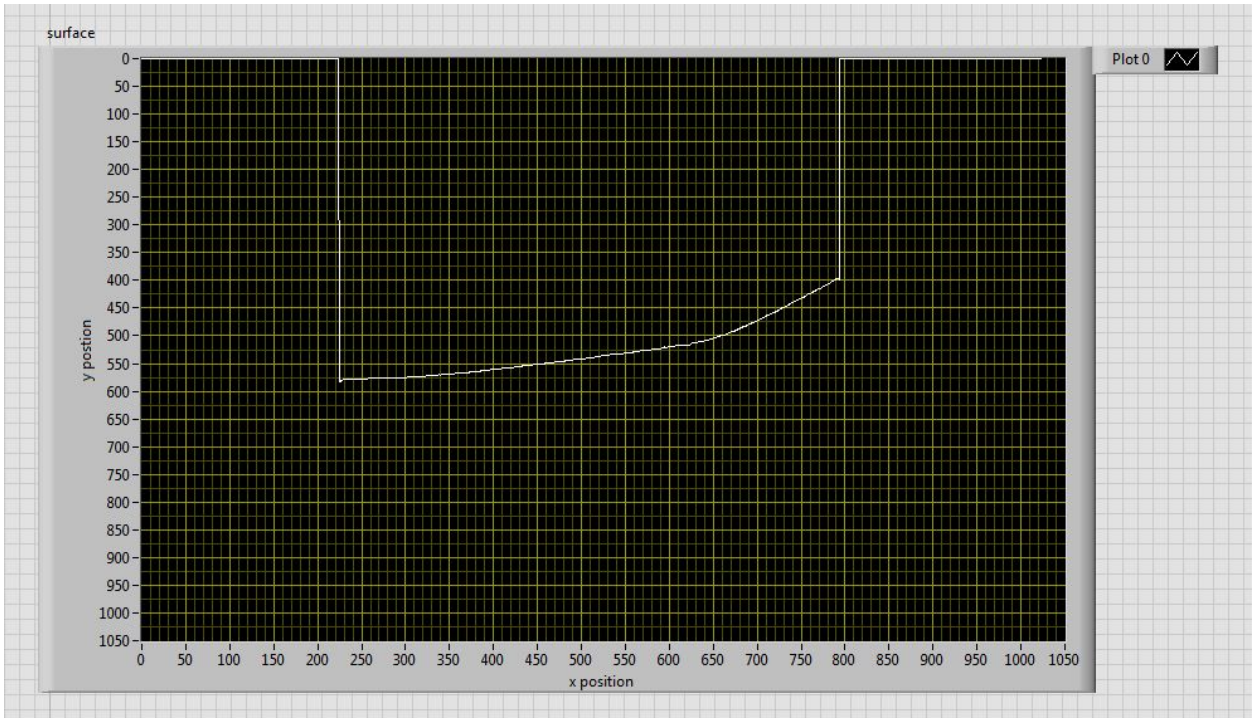
****Once the settings have been adjusted to allow foil detection (foil is a continuous red strip, the**

trailing edge does not fade in/out), stop the vi and proceed with the steps below.

17. Set edge position high limit (found in the surface finder settings panel). This sets the maximum y value, where the surface finder will stop trying to find a foil. Use this to speed up image processing. Maximum value is 1024.

- Ex: from watching the surface chart, the foil never gets beyond y=1000. Set the edge position high limit to 1000 to prevent the vi from looking for the foil at the bottom of the chart.

Surface finder chart:

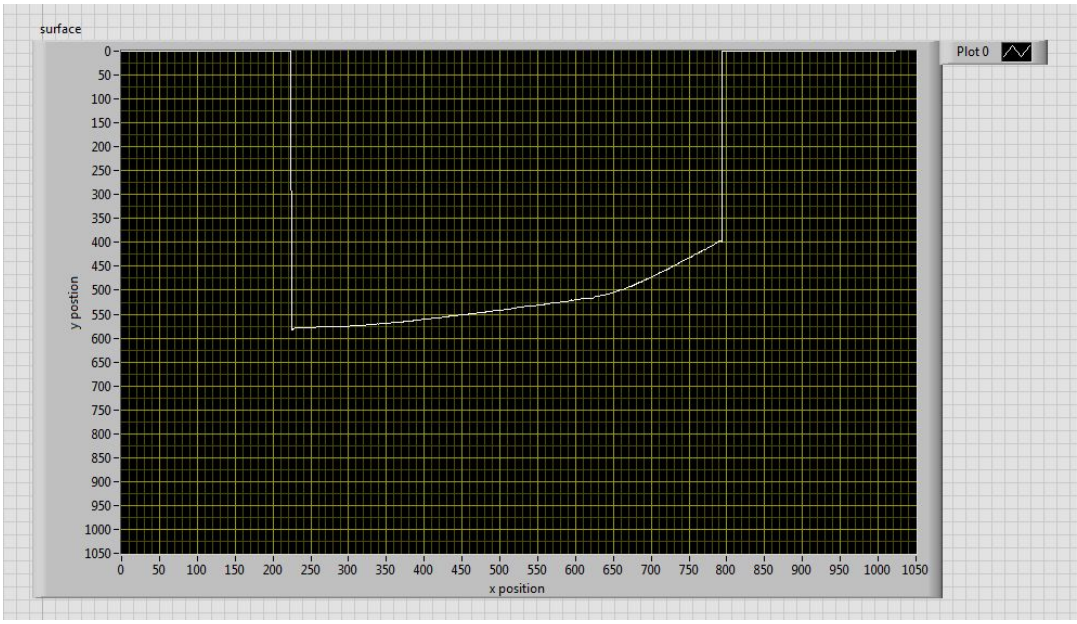


18. Look at the surface chart on the front panel (A). To speed up analysis, turn the analyze all image columns switch OFF (B) and set the start/stop indices as follows.

*It may be helpful to right click on the surface finder chart and select X Scale > Formatting from the pop-up menu. Choose the Scales tab. Adjust the Minimum and Maximum for the x and y axes to

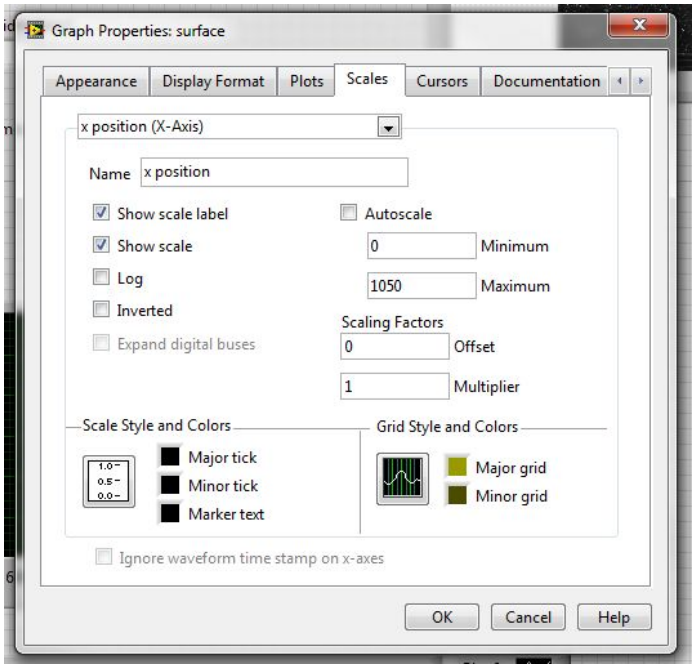
zoom in on the leading or trailing edge as appropriate. (See C)

A.



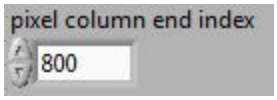
B.

C.



19. Determine the approximate x-value on the surface chart for the trailing edge of the foil. In the sample image, the x-value is about 790 (see step 18, image A). Set pixel column end index to a number larger than the trailing edge pixel.

- If the trailing edge drifts in the Flapper AVI, you may need to run the vi for ~100-200 frames to find the largest value of the trailing edge. The end index must be larger than this value.

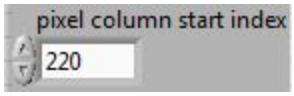


20. Determine the pixel column start index value (A).

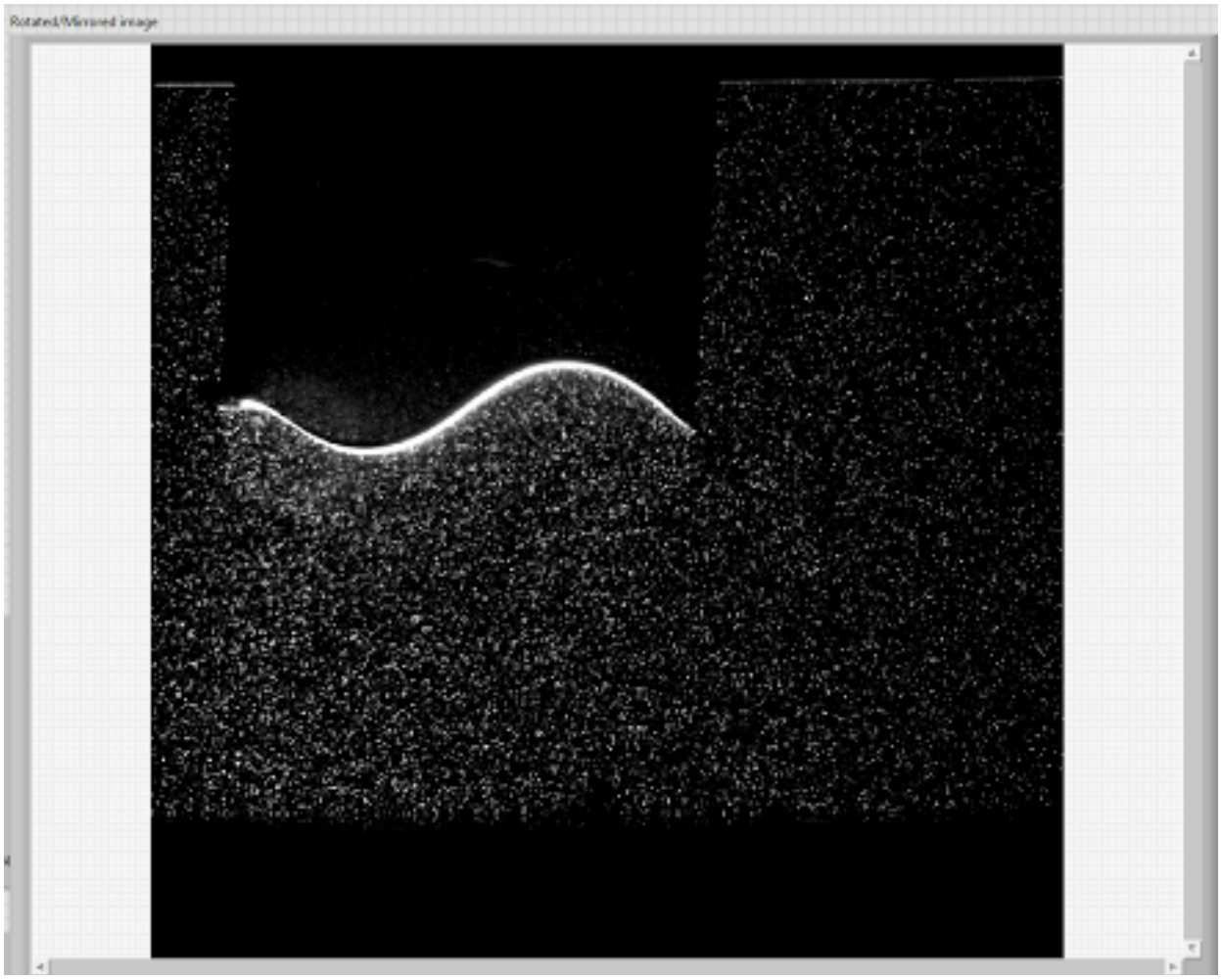
- Zoom in on the leading edge as described above in step 17.
- Option 1 - If rod will be simulated or is not desired in analysis:
  - Look for a transition:
    - ➢ If the rod is distinguishable from the foil (as in sample image B), the transition between them should be an obvious dip in the detected surface (C).
    - ➢ If the rod is difficult to distinguish, look for a consistent drop in the y-value from a y near the foil to y=0 (D).
  - Set the pixel column start index to the first pixel after the transition (for the sample image B/C, this would be 101).
- Option 2 - If rod will be detected:
  - Look for a transition:
    - ➢ Look for a consistent drop in the y-value from a y near the rod to y=0 (D).

- Set the pixel column start index to the first pixel after the transition (for the sample image D, this would be 225).

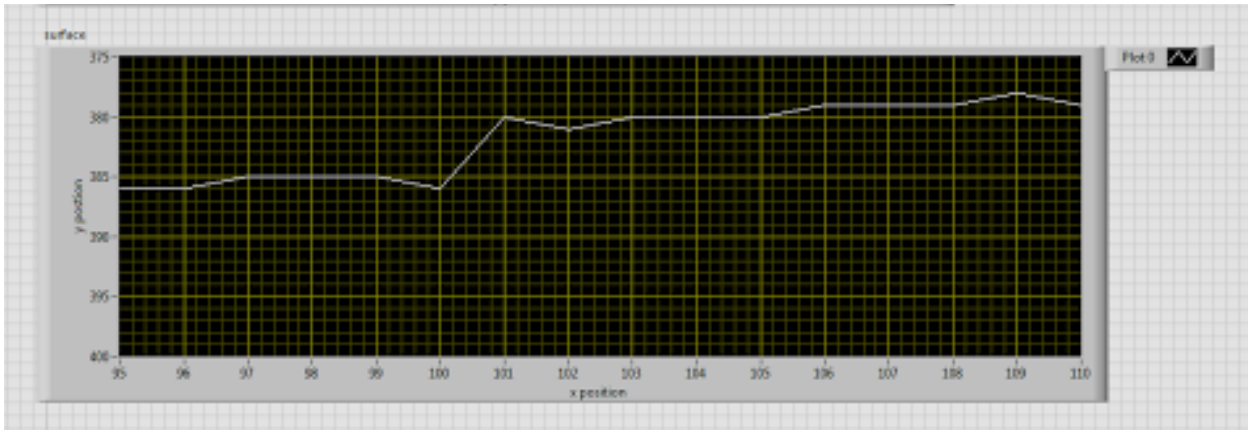
A.



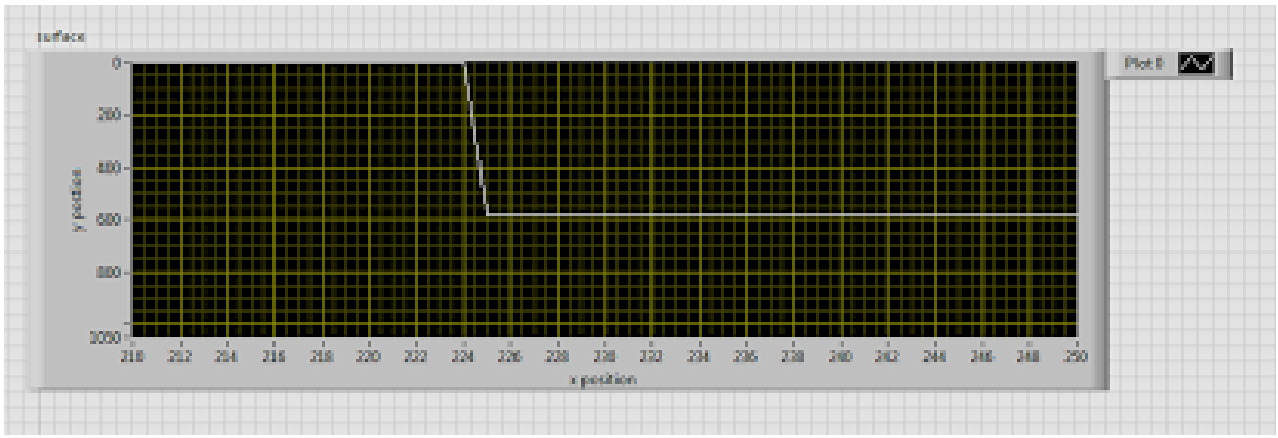
B.


Rotated/Mirrored image

C.

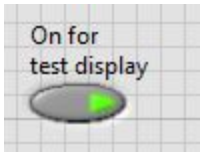

surface
Plot 0
y position
x position
375
380
385
390
395
400
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110

D.

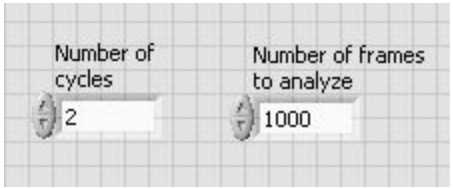


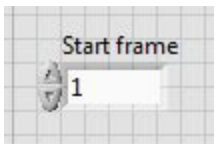
Steps 21-28 - for running the full analysis on the AVI

21. Turn the “On for test display” switch OFF (optional, but speeds up image processing).



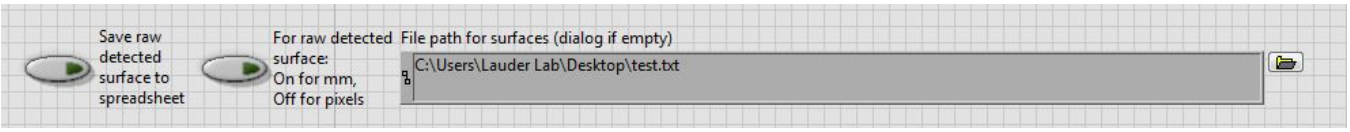
22. Verify that the number of frames to analyze control is set to the total number of frames from the Flapper AVI. Verify that the number of cycles is set to the total number of motion cycles that the foil completes during the Flapper AVI. Verify that the start frame is set to the frame where you want analysis to begin.





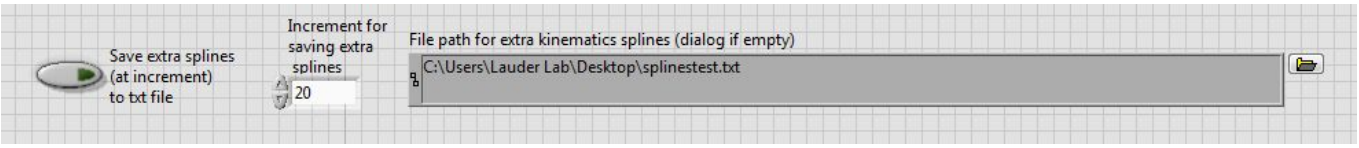
23. If raw detected surfaces are desired (often for debugging):

- Turn on the “save raw detected surface to spreadsheet” switch, overriding the defaults.
- Set the switch to the right of that to get the desired units for the raw detected surfaces.
- Set the filename and path where detected edges (including zeros for “none found” - see Detailed Description). File format is txt.



24. If extra kinematics splines are desired (for use with check_spline_fit.m - plot splines on top of original video):

- Turn on the save extra splines switch, overriding the defaults.
- Set the increment at which splines will be saved (ex: 20 for save a spline every 20 frames)
- Set the filename and path where extra splines (each spline as a list of 204 points) will be saved. File format is txt.



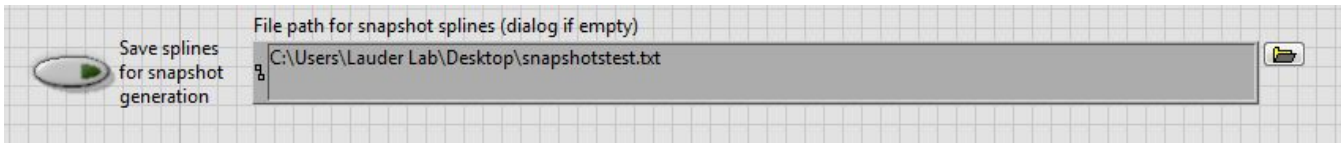
25. If kinematics animation (AVI) is desired:

- Turn on the “save an avi” switch, overriding the defaults.
- Set the increment at which frames will be saved (ex: 20 will display frame 1, 21, 41, etc). This reduces files sizes and increases playback speed.
- Set the filename and path where kinematics AVI will be saved. File format is AVI.

26. If splines for kinematics snapshots are desired:

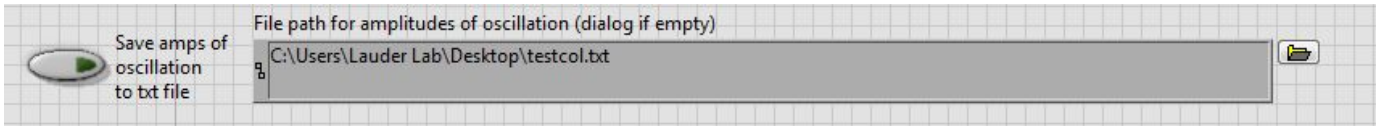
- Turn on the save splines switch, overriding the defaults. This will cause 24 evenly spaced (over time) splines per motion cycle to be exported.

- Set the filename and path where the snapshot splines (each spline as a list of 204 points) will be saved. File format is txt.



27. If amplitudes of oscillation along the foil are desired:

- Turn on the save amps of oscillation switch, overriding the defaults. This will cause amplitude of oscillation at 13 equally-spaced points along the foil (1=leading edge, points at 1/12s of the way down the foil, 13= trailing edge) per motion cycle to be saved in a list.
- Set the filename and path where amplitudes of oscillation will be saved. File format is txt.



28. Hit run.

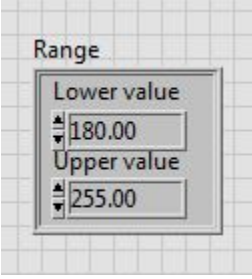
- The current image number counter will indicate which frame the vi is currently analyzing.

- If the kinematics AVI saver is on, when the last frame is reached, a pop up window titled Figure 1 will appear. This will display the spline plots for each frame. The animation viewed in this window is what is saved as the kinematics AVI (but the AVI plays back slower than appears in this window).
- At the end, there will be a pause where the data files are written and the vi appears to be doing nothing. Do not hit stop; **the vi will stop automatically after the files have been written.** This can take up to a few minutes for large AVIs.
- Verify that the files appeared in the directories specified.

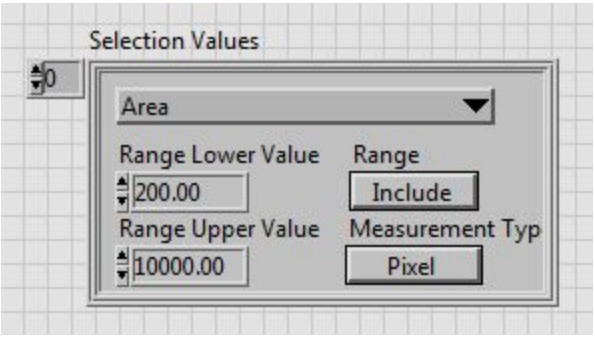
Settings:

The settings displayed are the default values, which are based on the following nonlinear foil video (from Oct 3, 2013):

Kelsey 1A(1B)\Oct3.foiltest.2013_paint\Glow.down.laserjustabove2.avi

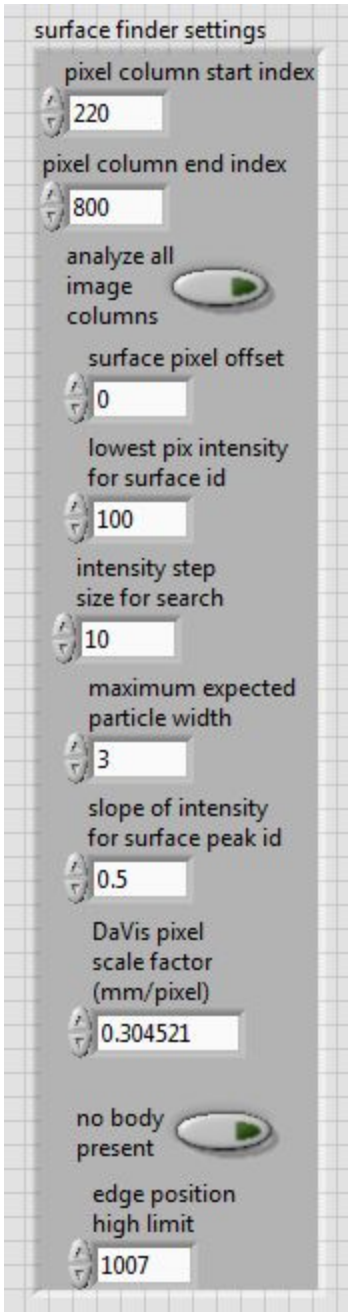


Range block: specifies the upper and lower pixel value thresholds used in the first pass of image processing. Here, the pixels with values in between are saved, and all other pixels are blacked out – removes noise and particles from image and retains only pixels that possibly belong to the foil. Maximum value is 255 (upper value). If the foil is dim, Lower value may need to be reduced. If there are very bright pixels in the foil AVI that do not belong to the foil, the Lower value may need to be increased or the Upper value decreased.



Selection Values block: Criteria for filtering remaining particles in the image after thresholding. Objects with an area within the specified range are kept, and the rest are removed.

- If the foil is small, the lower value of the range may need to be reduced (i.e., the foil is smaller than 200 pixels). Note that reducing the range lower value may introduce noise.
- If the foil is not the only thing displayed in the window that pops up when the vi is ran (i.e., random red speckles), the range lower value may need to be increased.
- Range upper value default (10,000) is an overestimate that should only be decreased if the display has only one red object, and this object is something other than the foil.

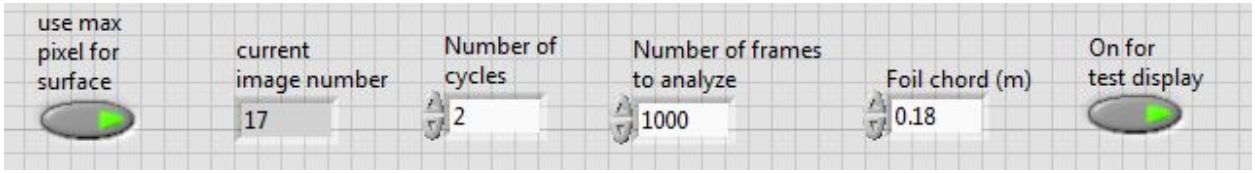


Surface finder settings block: settings used in identifying the foil from the particles remaining after filtering.

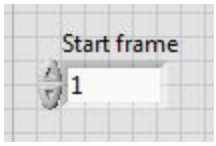
- Pixel column start index – determines where on the x-axis that the surface finder starts searching for the foil
- Pixel column end index – determines where on the x-axis that the surface finder stops searching for the foil
- Analyze all image columns switch – off allows user to set the start/stop pixel column index; on

causes the surface finder to search the whole field

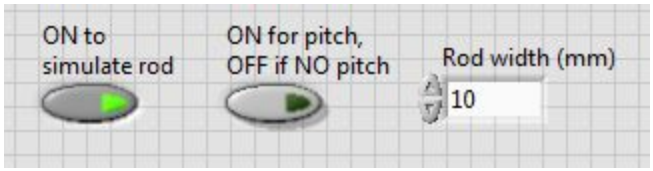
- Surface pixel offset – adds in this value to the detected y values; this accounts for foil thickness
- Lowest pix intensity for surface ID – sets what pixel intensity is the starting point for the sweep looking for the surface
- Intensity step size for search – the surface finder essentially takes multiple passes down a column looking for the pixels of the right intensity to be the foil. It starts searching pixel intensity with the "lowest pix intensity for surface ID," and if a foil is not found, it changes the intensity by this step size and searches again. This repeats until a pixel meeting intensity, slope, etc requirements are detected.
- Maximum expected particle width – sets expected maximum particle width in pixels
- Slope of intensity for surface peak ID – for each column of pixels in each image, the surface finder lists the intensity of pixels in the column (x-axis = y location, y-axis = pixel intensity). The peak intensities are the foil, but the foil has width and glare. The surface finder finds the slope of intensity between each set of adjacent pixels. This slope will be large but constant as approach the foil. When the foil is reached, intensity will plateau because the foil has thickness. Slope will approach zero. This setting determines the threshold that slope over 5 pixels must reach to be identified as the surface. Basically, the plot of intensities spikes and plateaus at the peak intensity, and this slope setting is used to find the transition between the rise and the plateau surface (the corner).
- DaVis pixel scale factor (mm/pixel) – the scale factor relating mm to pixels based on PIV calibration of the AVI in DaVis. Note that only exported data will be converted - the surface displayed on the front panel has units of pixels for settings purposes.
- No body present – ON indicates that there is not a surface in the field of view (default is OFF)
- Edge position high limit – sets maximum y value, where the surface finder will stop trying to find a foil if one has not yet been found. Maximum value is 1024.



- Use max pixel for surface – when the vi runs down each pixel column of the image to identify the edge (see Detailed Description), this switch determines how the edge is chosen. ON uses the pixel with the maximum intensity as the foil and is used when the foil is the brightest object. OFF causes the vi to search for the foil based on its expected width and the observed intensities in the column. Default is ON.
- Current image number – indicates which frame from the AVI that the vi is currently analyzing
- Number of cycles - set by user; tells vi how many motion cycles the foil goes through during the AVI
- Number of frames to analyze – set by user; tells the vi how many frames from the AVI to analyze (ex: set to 25 to run a small test)
- Foil span (m) - set by user; tells the vi the span of the foil in meters, which is used for normalizing some data
- On for test display - makes the black and red preview window of the filtered image display if ON and hides this display if OFF.



- Start frame - set by user; tells the vi which frame in the foil AVI that it should start analysis at.



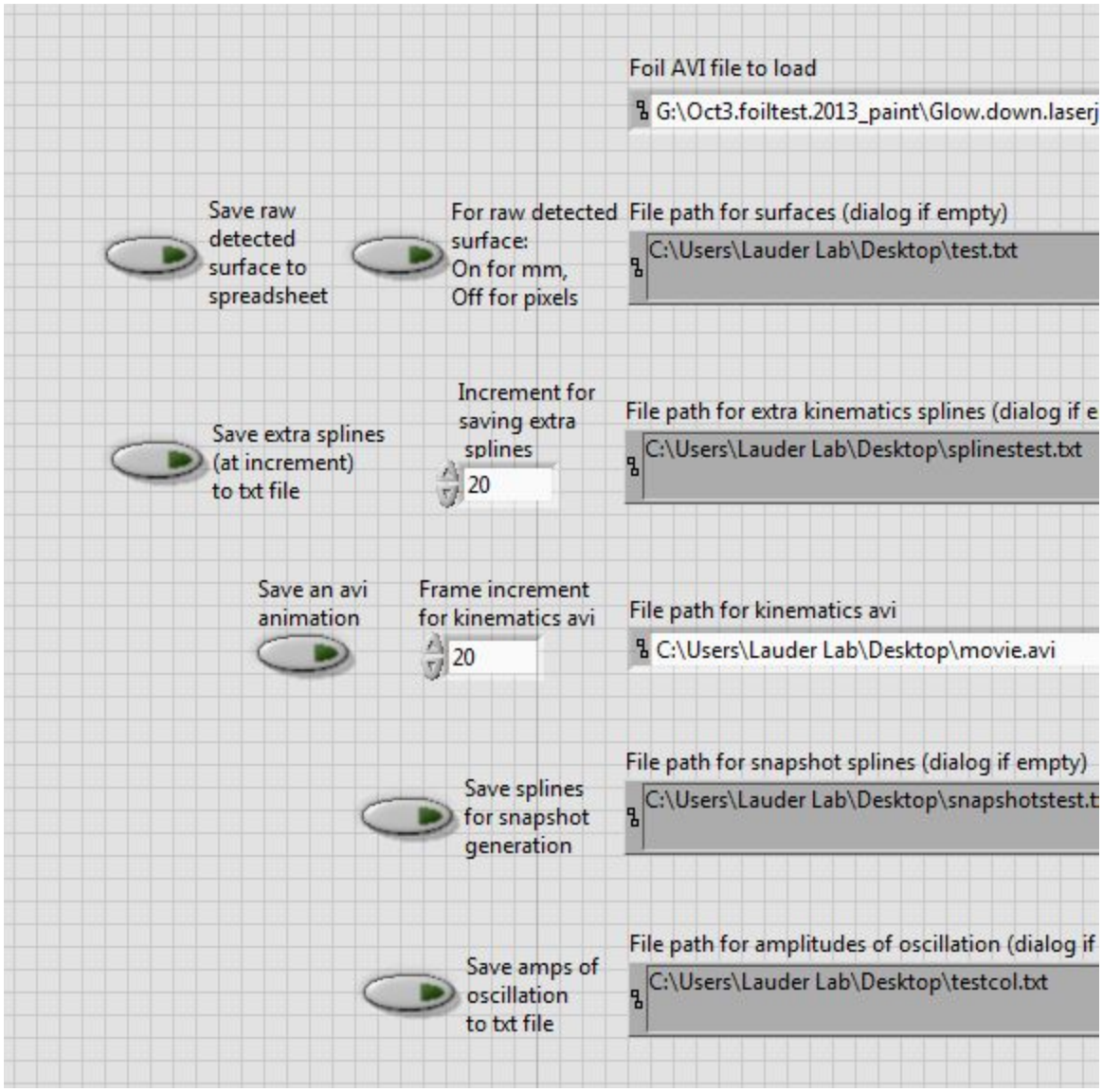
- ON to simulate rod - when this push button is on, the rod is simulated in one of two ways, depending on if the pitch button to the right is on (see below for description). The rod needs to be simulated when the following apply:
    - The user needs the rod to be taken into consideration
    - AND if one of the following applies:
        - The rod is not bright enough to be detected
        - The rod is excluded from detection using the pixel start index column feature

  *The default for this switch is ON.

- ON for pitch, OFF if NO pitch - Determines which method will be used to simulate the rod (see below). This button is disabled when the "ON to simulate rod" switch to the left is OFF.
    - This button should be ON if the foil is pitched. This causes the rod to be simulated using a best fit line (based on the first 50 pixels of the foil) extended from the detected foil's leading edge.
    - This button should be OFF is the foil is not pitched. This causes the rod to be simulated using a horizontal line extended from the detected foil's leading edge.

  *The default for this switch is OFF.

- Rod width (mm) - the width of the rod is specified by the user here. This tells the vi how far to extend the simulated line from the leading edge of the foil.



**For all the switches in this image, default setting is OFF.

- Save raw detected surface to spreadsheet - when on, saves the raw detected surface (including zeros where “none found” - see Detailed Description) in either pixels or mm to a txt file

- For raw detected surfaces: On for mm, Off for pixels - allows the user to toggle which units the raw detected surfaces will be saved in
    - This control and the file path block will be disabled when the Save switch to the left is off.

- Save extra splines (at increment) to text file - when on, saves splines at user-specified increment to a txt file, in addition to the 24 splines saved out for snapshot graphics.

- Increment for saving extra splines – set by user; tells the vi the increment at which splines are written to the text file (20 means save spline 1, 21, 41, etc)
    - This control and the file path block will be disabled when the Save switch to the left is off.

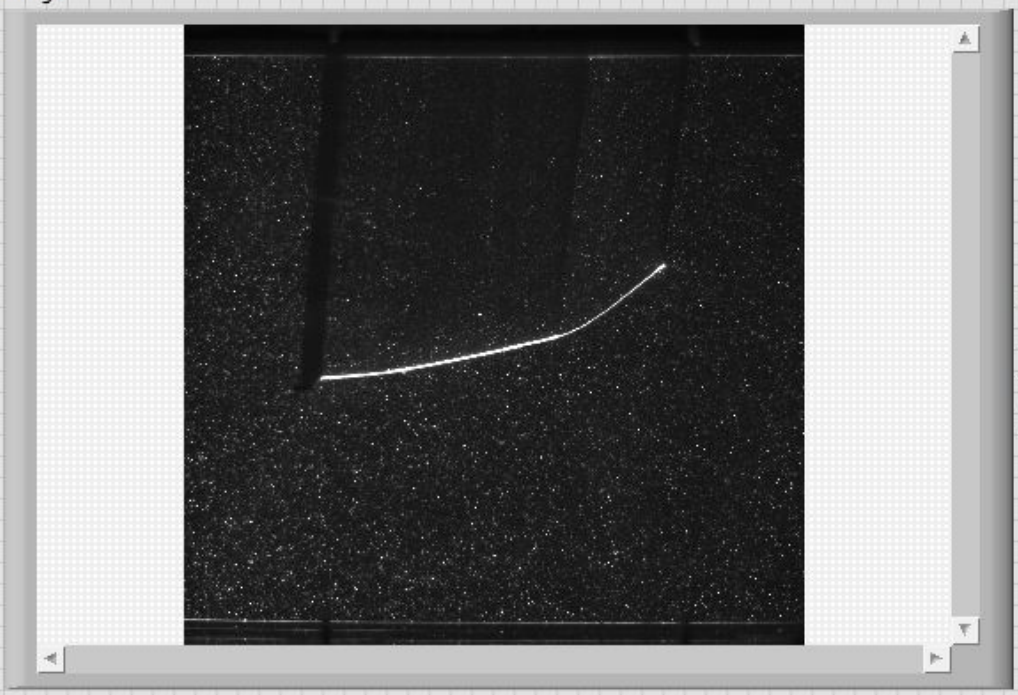
- Save an avi - when on, saves an AVI animation of foil kinematics.

- Frame increment for kinematics avi - set by user; tells the vi the increment at which frames are written to the AVI file (20 means write frames 1, 21, 41, etc). This increases playback speed and reduces file sizes.
    - NOTE: the AVI plays back slower than it does during the file write process.
    - This control and the file path block will be disabled when the Save switch to the left is off.

- Save splines for snapshot generation - when on, saves 24 kinematics splines per motion cycle to txt file. This file can be read into other programs to make snapshot figures.
    - This control and the file path block will be disabled when the Save switch to the left is off.

- Save amps of oscillation to txt file - when on, saves a list of amplitudes of oscillation at 13 points along the foil (1=leading edge, 2=1/12th of foil length, etc, 13=trailing edge) per motion cycle to a txt file. This file can be read into other programs to make amplitude of oscillation figures.
    - This control and the file path block will be disabled when the Save switch to the left is off.

Image



X Resolution

1024

Y Resolution

1024

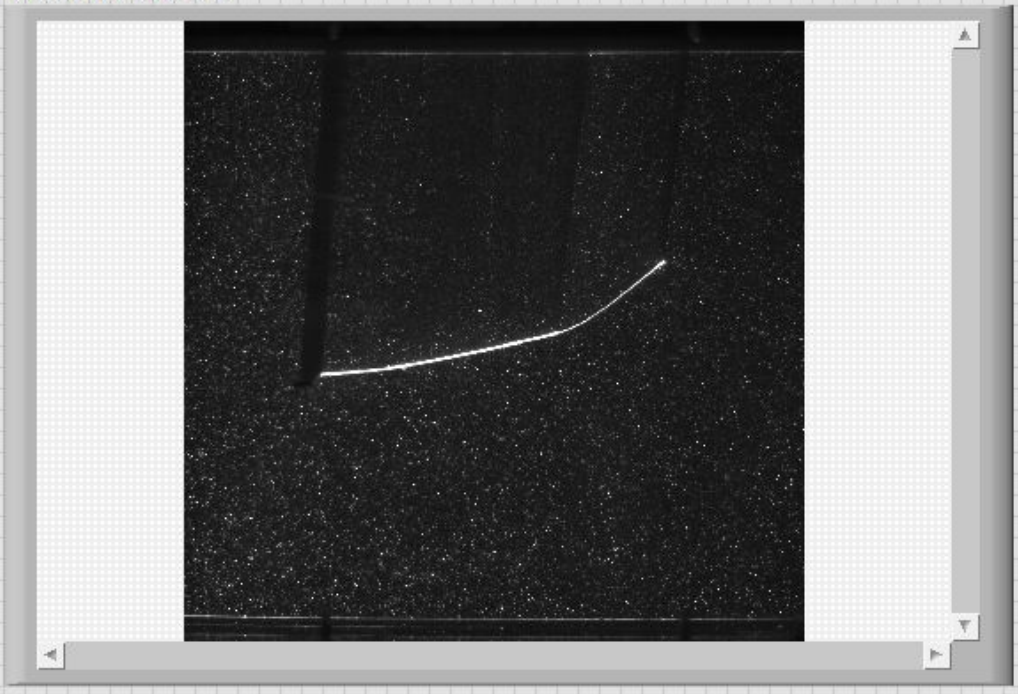
Flip along horizontal line

Flip along vertical line

Rotate 180 deg

Rotate 90 deg (CCW)

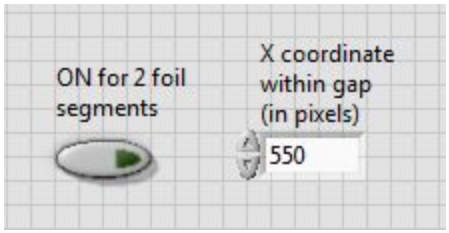
Rotated/Mirrored image



- Image - displays Flapper AVI
- Flip along horizontal line - mirrors the image across a horizontal line
- Flip along vertical line - mirrors the image across a vertical line
- Rotate 180 deg - rotates the image 180 degrees
- Rotate 90 deg (CCW) - rotates the image 90 degrees counterclockwise
- Rotated/Mirrored image - displays the Flapper AVI after rotation/mirroring to allow the user to verify that the correct options have been selected

To get specific rotations:

- 90 degrees counterclockwise - turn Rotate 90 deg (CCW) switch on
- 180 degrees - turn Rotate 180 deg switch on
- 270 degrees counterclockwise (or 90 degrees clockwise) - turn on these two switches: Rotate 180 deg, Rotate 90 deg (CCW)



- ON for 2 foil segments - toggles between detecting 1 body (one complete foil) and detecting 2 bodies (for when 2 segments of the foil are visible and separated - like when filming over a “peduncle” gap) modes. Default is OFF - detect 1 body.

- X coordinate with gap (in pixels) - x-coordinate value in pixels (NOT mm) located in the gap between the two foil segments, specified by the user. Only functions in the 2 foil segments mode.