



Image Filtering in ProAnalyst®

Date Published: March 2010

Abstract

This application note describes image filtering, a subsection of the overall process of image processing -- manipulating your video to get the highest image quality in order to achieve the best possible tracking results. This is a detailed account of how image filtering works in ProAnalyst. Adding and removing specific filters, modifying filter properties, and a list of ProAnalyst's available filters are included.

Image Filtering

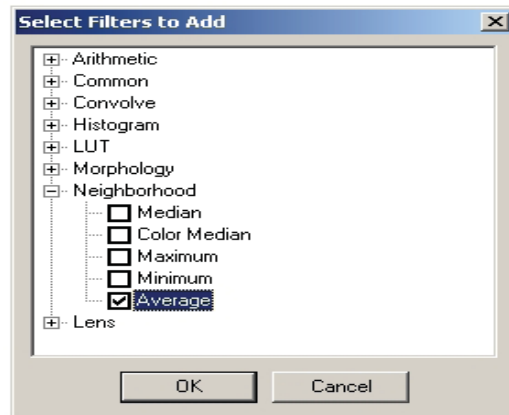
A sequence of image filters can be applied to video images. These filters can be added using the Image Filtering control panel shown on the following page.

The upper portion of the panel lists the current filters that have been added and whether or not they are active. Check or uncheck the box next to each filter to enable that filter. The order of the filters can be changed by selecting a filter and then clicking the **Move Up** and **Move Down** buttons.



Adding and Removing Filters


New filters can be added by clicking the **Add** button. New filters are always added to the end of the sequence. Use the **Move Up** and **Move Down** buttons to change the order of the sequence. When you click the Add button, the Add Filter dialog will appear.

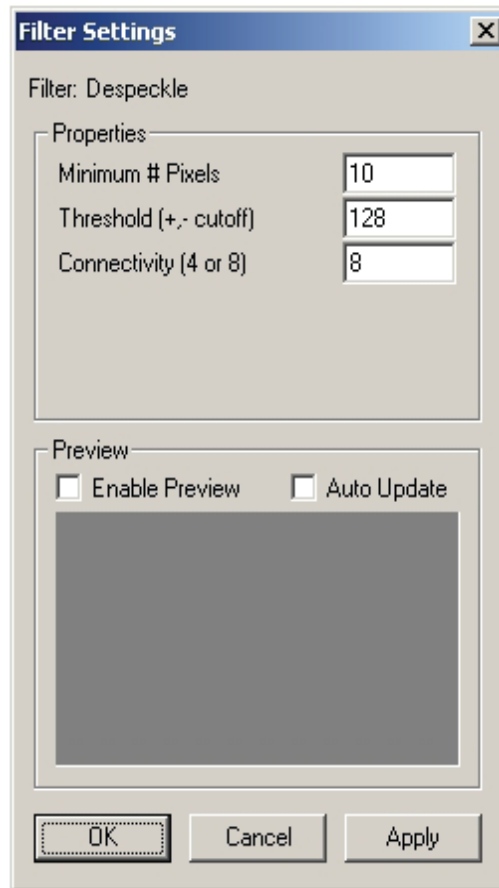


Select the Filter Class and the Filter Type of the filter that you wish to add. Filters can be removed by selecting a filter in the list and then clicking the **Remove** button. To remove all filters, click the **Clear** button located at the bottom of the control panel.

Modifying Filter Properties

After a filter has been added, you cannot change the Filter Class, but you can change the Filter Type. To change the Filter Class, remove the filter and add a new filter of the correct class. To change the Filter Type, click on the filter in the list and select a new Filter Type from the drop-down box in the lower portion of the control panel.

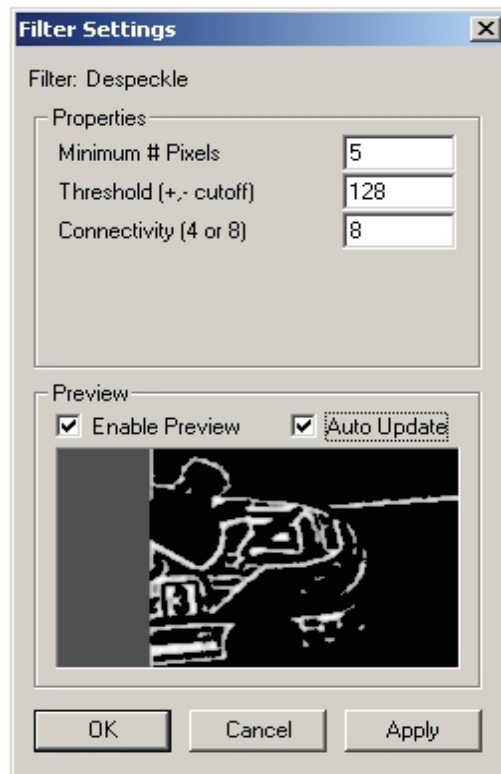
Some filters have editable properties and others do not. When you double-click on a filter in the list that has editable properties or click on the **Wrench** icon  in the list, these properties will be displayed in a separate pop-up dialog window.



Edit the properties and then click **Apply** for the changes to take effect.

Enabling Preview

A preview option is available to help in tuning the filter properties. To enable the preview, check the **Enable Preview** checkbox in the lower portion of the pop-up dialog window.



The portion of the video that is displayed in the preview region can be adjusted by clicking and dragging within the preview area.

The preview area will display the processed video with all filters applied up to and including the current filter. The filters in the filter list after the current selected filter are not applied to the image displayed in the preview area.

If the Auto Update checkbox is selected, then the parameters entered into the upper portion of the dialog will be automatically applied to the current filter for the preview image without having to be applied. If Auto Update is not checked, You must click the Apply button in order to see the effect of any parameter changes.

Note: A set of filters can be saved to a file. This file can then be reloaded for another video or multiple sets of filters can be defined for a single video. To save or load image processing settings, use the Save and Load buttons at the top of the control panel.

Note: Image filters and settings are saved to files with the .imp extension.

List of Available Filters

The filters listed on the following pages are available with ProAnalyst.

Arithmetic -- Perform basic arithmetic operations on all pixels in the image.

Addition/Subtraction	Adds or subtracts a specified parameter value from all pixels in the image. Use positive values to add and negative values to subtract.
Pre-Subtraction	Subtracts all pixels in the image from a specified parameter value. Parameter value should be positive.
Multiplication	Multiplies all pixel values with a specified parameter value.
Multiplication (Scaled)	Multiplies all pixel values with a specified parameter value with scaling, so that the maximum value is limited to 255.
Square	Squares each pixel in the image.
Left Bit Shift	Performs a left bit shift (<<) operation on all pixels in the image. Shifts by a specified number of bits.
Right Bit Shift	Performs a right bit shift (>>) operation on all pixels in the image. Shifts by a specified number of bits.
Logical NOT	Performs a logical NOT (~) operation on all pixels in the image.
Logical AND	Performs a logical AND (&) operation with a specified parameter value for all pixels in the image.
Logical OR	Performs a logical OR () operation with a specified parameter value for all pixels in the image.
Logical XOR	Performs a logical XOR (^) operation with a specified parameter value for all pixels in the image.

Common -- Common image operations such as thresholding and despeckling

Threshold (Binary)	Performs a threshold operation on the image. All image pixels below the threshold will be set to black (0). All image pixels above the threshold will be set to white (255).
Threshold (Mask)	Performs a threshold operation on the image. All image pixels below the threshold will be set to black (0). All image pixels above the threshold will be set to the original image value.
Despeckle	Removes speckles in the image beneath a given size and threshold. The image is first thresholded using a fixed grayscale parameter value. Then all speckles beneath a given size are removed. Speckle size is computed assuming four point connectivity or eight point connectivity. Four point connectivity means that only points to the left, right, top, and bottom will be considered connected to a given pixel. Eight point connectivity also includes the diagonal upper-left, upper-right, lower-left, and lower-right pixels.
Zero Border	Sets all pixel values to zero near the left, right, top, and bottom borders.
Frame Difference	Computes the difference in pixels from the previous frame to the current frame. Only one of these filters may be active at a time. If multiple are added, only the first one will be enabled. The single option to this filter controls the style of differencing that is computed. If the style is 0, then the absolute difference between frames is computed. If the style is -1, then the current frame A is subtracted from the previous frame B, with only positive values displayed. If the style is 1, then the previous frame B is subtracted from the current frame A, with only positive values displayed.
Strobe Effect	Produces images that are a combination of all previously displayed images by performing a logical OR operation with every new frame. To reset the combined image, disable and reenable the filter by clicking on the check box next to this filter in the filter list. Only one of these filters may be active at a time. If multiple are added, only the first one will be enabled.
Flip Horizontal	Flip the image horizontally.
Flip Vertical	Flip the image vertically.
Flip Both (Rotate 180)	Flip the image horizontally and vertically. This is equivalent to rotating the image 180 degrees.
Zero Region	Sets all pixel values to zero within the rectangular region defined by the left, right, top, and bottom values.
Local Background Removal	Performs approximate background removal by using local averaging.
Alpha Blending	Blends each displayed image with the previously displayed images using the alpha value specified. The alpha value should be between 1 and 255. A value of 1 will keep the original frame, ignoring all new frames. A value of 255 will always show the new frame, ignoring all previous frames. The type controls how the images are blended. (More information on type is pending. It is recommended you use the default value of 3.)
Initial Frame Background Removal	Performs approximate background removal by checking for differences above a specified threshold from the first frame of video. If a pixel value is above the specified threshold, it is displayed normally. If a pixel value is below the specified threshold, it is displayed as black.

Convolve -- Convolution of the image with fixed convolution filters. The actual filter coefficients are provided at the end of the descriptions, each row is separated by a semicolon.

Vertical Edges (3x3 Prewitt)	Convolve the image with a vertical Prewitt gradient filter to find vertical edges. [-1 0 1 ; -1 0 1 ; -1 0 1]
Horizontal Edges (3x3 Prewitt)	Convolve the image with a horizontal Prewitt gradient filter to find horizontal edges. [1 1 1 ; 0 0 0 ; -1 -1 -1]
Vertical Edges (3x3 Sobel)	Convolve the image with a vertical Sobel gradient filter to find vertical edges. [-1 0 -1 ; -2 0 2 ; -1 0 1]
Horizontal Edges (3x3 Sobel)	Convolve the image with a horizontal Sobel gradient filter to find horizontal edges. [1 2 1 ; 0 0 0 ; -1 2 -1]
Edge Detector (3x3 Laplacian High Pass)	Convolve the image with a Laplacian high-pass filter to find edges. [-1 -1 -1 ; -1 8 -1 ; -1 -1 -1]
Edge Detector (5x5 Laplacian High Pass)	Convolve the image with a Laplacian high-pass filter to find edges. [-1 -3 -4 -3 -1 ; -3 0 6 0 -3 ; -4 6 20 6 -4 ; -3 0 6 0 -3 ; -1 -3 -4 -3 -1]
Smoothing (3x3 Gaussian)	Convolve the image with a Gaussian low-pass filter to smooth the image. [1 2 1 ; 2 4 2 ; 1 2 1] / 16
Smoothing (5x5 Gaussian)	Convolve the image with a Gaussian low-pass filter to smooth the image. [2 7 12 7 2 ; 7 31 52 31 7 ; 12 52 127 52 12 ; 7 31 52 31 7 ; 2 7 12 7 2] / 571
Edge Detector (3x3 Center High Pass)	Convolve the image with a basic high-pass filter to find edges. Equivalent to the Laplacian (3x3). [-1 -1 -1 ; -1 8 -1 ; -1 -1 -1]
Edge Detector (5x5 Center High Pass)	Convolve the image with a basic high-pass filter to find edges. [-1 -1 -1 -1 -1 ; -1 -1 -1 -1 -1 ; -1 -1 24 -1 -1 ; -1 -1 -1 -1 -1 ; -1 -1 -1 -1 -1]
Sharpening (3x3 Center)	Convolve the image with a basic sharpening filter to sharpen the image. [-1 -1 -1 ; -1 16 -1 ; -1 -1 -1] / 8
Checker Corner Detector	Convolve with two filters to locate corners of checkerboard patterns, one filter to locate black-white,white-black checkerboards and the second to locate white-black,black-white checkerboards.

Histogram -- Many of the following operations require a range to be specified as a parameter to the filter. A range is specified by three RGB center values and three RGB ranges. A pixel value is inside the range if it is within $R \pm dR$, $G \pm dG$, and $B \pm dB$, where dR , dG , dB are the RGB ranges.

Color Select (Binary)	Selects pixels in the image that are within a specified color range. If a pixel is outside the range, the output pixel is set to black (0). If a pixel is within the range, the output pixel is set to white (255).
Color Select (Mask)	Selects pixels in the image that are within a specified color range. If a pixel is outside the range, the output pixel is set to black (0). If a pixel is within the range, the output pixel is set to the original pixel value.
Inverse Select (Binary)	Selects pixels in the image that are outside a specified color range. If a pixel is outside the range, the output pixel is set to white (255). If a pixel is within the range, the output pixel is set to black (0).
Inverse Select (Mask)	Selects pixels in the image that are outside a specified color range. If a pixel is outside the range, the output pixel is set to the original pixel value. If a pixel is within the range, the output pixel is set to black (0).
Equalize	Computes the histogram of the image and performs a remapping so that the resulting histogram attempts to equalize the occurrence of each pixel value.

LUT -- The following operations are equivalent to the controls in the Image Processing panel.

Brightness	Modify the brightness of the image. A single parameter value between -255 to +255 is used to adjust the brightness. Negative values will make the image darker, positive values will make the image brighter.
Contrast	Modify the contrast of the image. A single parameter value between -255 to +255 is used to adjust the contrast. Negative values will decrease the white-black difference, positive values will increase the white-black difference.
Gamma (x10)	Modify the gamma of the image. A single parameter value between 0 to 100 is used to adjust the gamma. Values are 10x the conventional values, for instance 20 would be a gamma of 2.0.
Nonlinear	Applies an nonlinear (exponential/logarithmic) LUT to the image. A single parameter value between -255 to +255 is used to adjust the nonlinear LUT. Negative values will apply an exponential LUT, positive values will apply a logarithmic LUT.
Reverse	Reverses the image, making white black and black white.

Morphology -- Morphological operations can be used to grow or shrink regions or open and close regions. Each operation can be repeated a specified number of times.

Make Thinner (Erode)	Performs erosion on the input image. The output pixel is set to the minimum of the pixel values in a 3x3 area around each input pixel.
Make Thicker (Dilate)	Performs dilation on the input image. The output pixel is set to the maximum of the pixel values in a 3x3 area around each input pixel.
Break Connections (Open)	Performs the specified number of erosion operations followed by the specified number of dilation operations.
Close Connections (Close)	Performs the specified number of dilation operations followed by the specified number of erosion operations.

Neighborhood -- A neighborhood is specified by providing width and height and anchor coordinates. The anchor specifies where the neighborhood is relative to the pixel of interest. For instance, for a 5x5 neighborhood to be centered on the pixel of interest, specify the anchor to be 3,3.

Median	Replaces each pixel in the output image with the median of pixels in the neighborhood of each pixel.
Color Median	Replaces each pixel in the output image with the median of pixels in the neighborhood of each pixel.
Maximum	Replaces each pixel in the output image with the maximum of pixels in the neighborhood of each pixel.
Minimum	Replaces each pixel in the output image with the minimum of pixels in the neighborhood of each pixel.
Average	Replaces each pixel in the output image with the average of pixels in the neighborhood of each pixel.

Lens -- Lens filters perform operations that are related to lens artifacts, such as radial distortion.

Radial Distortion	Compensates for radial lens distortion. Use the Lens Distortion Calculation Tool to calculate suitable parameters (the section called "Lens Distortion Calculation Tool").
----------------------	--

This application note is copyrighted by Xcitex Inc. and is supplied without specific warranty to any purpose and based on information currently available at the time of this writing. All specifications stated herein are subject to change without notice.

For further information on Xcitex products, visit www.xcitex.com or send an email to info@xcitex.com.

Xcitex Inc.
25 First Street, Suite 105
Cambridge, MA 02141 USA

