

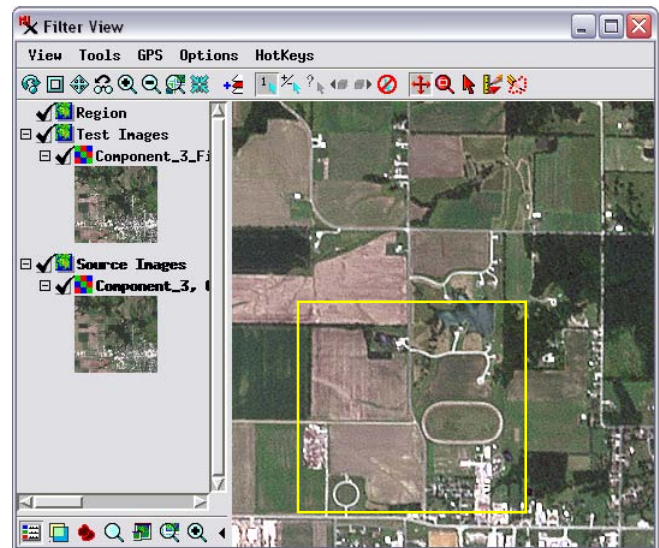
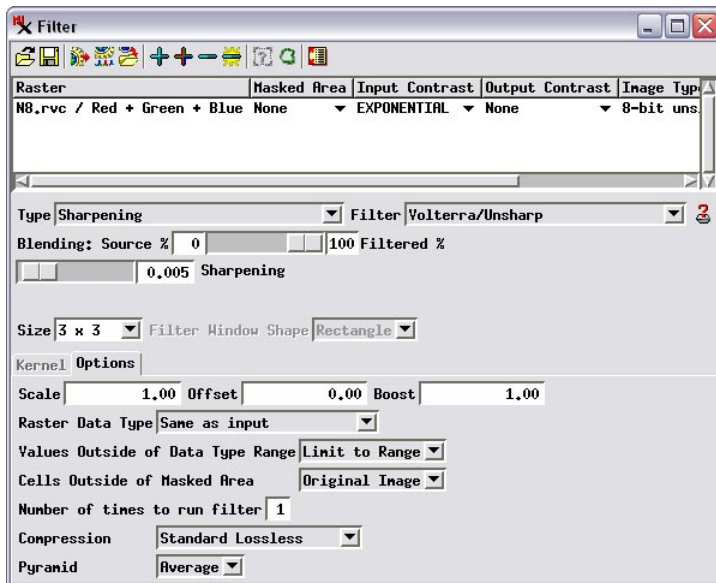
Spatial Filter Process

The Spatial Filter process in TNTmips (Image / Filter / Spatial Filter) allows you to permanently apply a variety of spatial filters to images of any type (grayscale, RGB color composites, and RGB color separates). Filters are provided for sharpening, smoothing and noise removal (including specialized radar filters), edge detection, and evaluating image texture. Any filter result can be automatically blended with the input image in any desired proportion. You can vary the filter size; design, import, save, and reuse custom filter kernels; and automatically repeat application of the filter a specified number of times. The integrated Filter View window allows you to define areas for testing (previewing) the current filter settings and to confine the filter action to specific portions of the image (see the Technical Guide entitled *Spatial Filter Testing and Masking*). The final filter result is also automatically added to the Filter View along with the input image for your review.

NOTE: you can also apply any spatial filter as a temporary display option using controls on the Filter tabbed panel of the Raster Layer Display Controls window.

described below for modifying the filter result for individual inputs. Right-click on any column heading to open a pop-in menu allowing you to sort the list based on that column's entries and to open a window allowing you to choose which columns to show in the list.

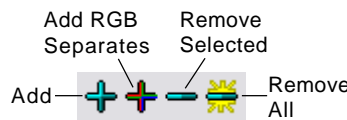
You can remove any or all inputs from the list using the Remove Selected and Remove All icon buttons. Left-click on a single entry to select it exclusively; left-click while pressing the Ctrl key to toggle selection for an item; or left-click while pressing the Shift key to select a range of entries.



Above, Filter View window displaying the result from applying the Volterra/Unsharp sharpening filter on a color image (RGB separates). The boxed area is shown at 1X for the input image (below left) and for the filtered result (below right).

Selecting Input Data

Use the Add icon button on the Filter window toolbar to select one or more grayscale raster images or color-composite images to filter. Use the Add RGB Separates icon button to choose a set of three raster objects corresponding to red, green, and blue components of a color image.



Color images (color-composites and RGB separates) are automatically filtered using a color transformation. The RGB image is transformed to Hue, Intensity, and Saturation components, (HIS color space) and the filter is applied to the intensity component. The image is then transformed back to the RGB color space using the filtered intensity component.

Individual input rasters and raster sets are shown in the list in the Filter window. Columns in the list show the raster name, image type, cell size, and dimensions and provide controls de-



Choosing a Filter

The spatial filters are subdivided into groups based on their purpose. Select one of the five filter groups from the Type menu: Sharpening, Edge Detection, Smoothing and Noise Removal, Radar, and Gray Level Co-occurrence Matrix. Choose the particular filter from the group using the Filter menu. A Technical Guide on each filter group describes the individual (over)

filters in that group and illustrates typical results for grayscale images.

Blending

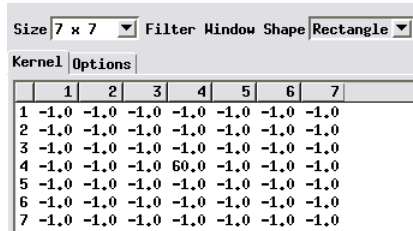
You can modulate an unduly extreme filter result by blending the result with the input image. The Blending slider control on the Filter window allows you to automatically blend the filter result with the input image in any proportion. Percentage values are shown on either side of the slider, with the Source image percentage on the left and the Filtered result percentage on the right. You can adjust the proportions by moving the slider or by entering a percentage value in either numeric field.

Filter Size and Shape

The spatial filters compute a new value for each image cell using values in a surrounding group of cells, known as the filter window. The Size menu allows you to choose a pre-defined filter window size (2 x 2, 3 x 3, 5 x 5, 7 x 7, and so on to 21 x 21). You can also set a custom size by entering a filter width value in the field and pressing Enter. Increasing the filter window size extends the filter effect to larger-scale image elements. For most filters you can also choose the window shape (Rectangle or Circle) from the Filter Window Shape menu.

Kernel Tabbed Panel

A number of the available spatial filters are linear convolution filters that use a set of kernel coefficients (weights) to compute a weighted average of the image cells in the filter window. Examples are the Low Pass/Average filter (Smoothing and Noise Removal) and High Pass and High Boost filters (Sharpening). When a convolution filter is selected, the Kernel tabbed panel is active and displays a matrix with the filter coefficients. (You can change the number of decimal places shown for the coefficients by pressing the Preferences icon button.) The kernel matrix is automatically resized when you change the filter window size.



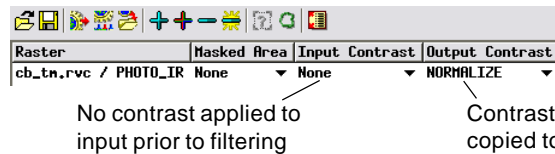
You can edit the coefficient values in the kernel matrix for any of the convolution filters to create a custom filter kernel. Editing any coefficient automatically changes the Filter menu to User Defined. You can save a custom filter kernel for re-use using the Save icon button in the Filter window toolbar. Choose Save Filter from the button's menu to save the kernel as an object in a Project File or Export Kernel to save the kernel in a space-delimited text file. Press the Open icon button to select a kernel for re-use: choose Open Filter to select the kernel object from a Project File or Import Kernel to read the kernel coefficients from a text file.

Input and Output Contrast

The Input Contrast and Output Contrast columns in the input list provide controls for setting contrast options to be applied to the input image (prior to filtering) and/or to the filtered result, respectively.

When you select grayscale raster objects for filtering, by default the Input Contrast option is set to None and the Output Contrast option is set to the last-used saved contrast table. With these settings, the specified filter is applied to the raw (uncontrasted) image values and the default contrast table is copied to the output raster and used automatically in displaying the result in the Filter View. The filtered result will therefore display automatically with similar contrast enhancement as the input image.

An input grayscale image may have more than one saved contrast table. You can set any of these contrast tables as the display default for the result. Simply left-click on the input's entry in the Output Contrast column and choose the desired contrast table from the menu. (The contrast menu also includes entries for standard auto-contrast options, such as Auto Linear and Auto Normalize, that you can select for displaying the result in the Filter View, but with these options no contrast table is saved.)



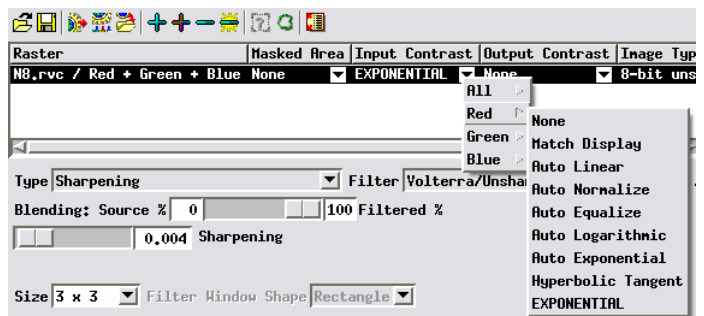
No contrast applied to input prior to filtering

Contrast table to be copied to filter result

You can choose to apply contrast to the input image prior to filtering by selecting a saved contrast table or an auto-contrast method from the Input Contrast menu for the image. This option is most useful for color input, as discussed below.

When you select a set of RGB separates (or a 24-bit or 16-bit color composite) as input, by default the Input Contrast option is set to the last-used contrast table for each color component and the Output Contrast option is set to None. (A single contrast table name is shown if the last-used table for each component has the same name, otherwise the contrast table names for all three components are shown.) Contrast is applied pre-filtering to color input so that contrast-enhanced RGB values are used in the color space transformation from RGB to HIS for filtering of the intensity component.

You can use the Input Contrast menu to choose any saved contrast table to apply to each color component. This menu has a submenu for each color component (Red, Green, and Blue) as well as an All submenu with standard auto-contrast options.



Use the Input Contrast menu to choose the contrast options to apply to the components of RGB separate or color-composite inputs.

Masked Area

The menu in the Masked Area column in the input list lets you limit the filter effect to a particular area of an input using either a pre-existing binary raster or a region object (a pre-existing region or a temporary region created using the Define Region tools in the Filter View). Masked Area in this usage refers to the image area to which the filter is applied. See the TechGuide entitled *Spatial Filter Testing and Masking* for details.

Options Tabbed Panel

The Options tabbed panel provides controls for a number of process settings, including standard menus for choosing an optional compression method for the filter result and the raster pyramid type. A number of options specific to the Spatial Filter process are also provided.

The Scale, Offset, and Boost fields let you apply a global algebraic transformation to all output cell values. These parameters are applied according to the following formula:

$$\text{Modified Output} = ((\text{Initial Output} * \text{Boost}) + \text{Offset}) / \text{Scale}$$

The default values of Scale = 1.0, Offset = 0, and Boost = 1.0 result in no change to the filtered cell values.

Use the Raster Data Type menu to choose the data type of the filter result. You can choose from a range of grayscale raster data types, including unsigned integer, signed integer, and floating point raster of various bit-depths, or simply choose Same as

Input to replicate the data type of the input image. Some of the specialized filters, such as those in the Gray Level Co-occurrence Matrix texture group, may produce a raw filter output with a narrow range of floating point values; the default 32-bit floating-point data type is the best choice to preserve the details of the output for these filters.

The Values Outside of Data Type Range menu provides two options for processing out-of-range output cell values. The Limit to Range option sets the filtered value to the closest data range limit (minimum or maximum). The alternative option is Set to Null.

The Cells Outside of Masked Area menu provides two options for the image cells not being filtered. You can either transfer the raw image cell values to the filter result, or set these cells as null.

You can choose to apply the same filter repeatedly with the same parameters by setting a value greater than 1 in the *Number of times to run filter* field.

Running the Process

After you set the desired filter options, press the Run icon button to run the process immediately. Standard Queue Job and Save Job icon buttons are also provided to apply the filter using Job Processing; see the TechGuide entitled *System: TNTmips Job Processing System* for more information.

