MV Tool

Machine Vision Library
Demonstration Application

USER'S GUIDE

Rev 1.1
October 2005

www.rwautomation.com

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1) Legal Notices

1.1) Copyright

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2) Introduction

The MV Tool application was created to allow users to experience the features of the MV Lib machine vision library. When reading this document, it is helpful to refer to the MV Lib user's guide in order to understand the functionality presented in the MV Tool application UI.

2.1) Features

MV Tool allows the user to access the following features of MV Lib:

-Several image types to allow processing of images over wide dynamic ranges.
-Image creation, copy, paste, load from disk, save to disk.
-Image graphics and image generation.
-Image algebra.
-Image transforms, pixel mapping, contrast manipulation, geometric transforms.
-Filters, low pass, high pass, order-statistic, generic sliding window.
-2-D Fourier transforms.
-Image morphology
-Normalized correlation search.
-Fiducial localization.
-Image segmentation, connectivity, and watershed analysis.
-Image projections.
-Image statistics and scene angle finder.

2.2) Installation

The MV Tool application runs under Microsoft Windows 95/98/2000/XP operating systems. It is distributed as a single self-extracting setup executable file. Simply run the setup file and follow the instructions. The MV Tool application, along with this document, the MV Lib user's guide, and an uninstall utility are all provided in the distribution file.

2.3) Running MV Tool

When MV Tool is first started, a reduced menu is available to the user as shown in the screen shot below. This menu continues to be displayed until an image is loaded. Each image will be displayed in a child window within the MV tool application.
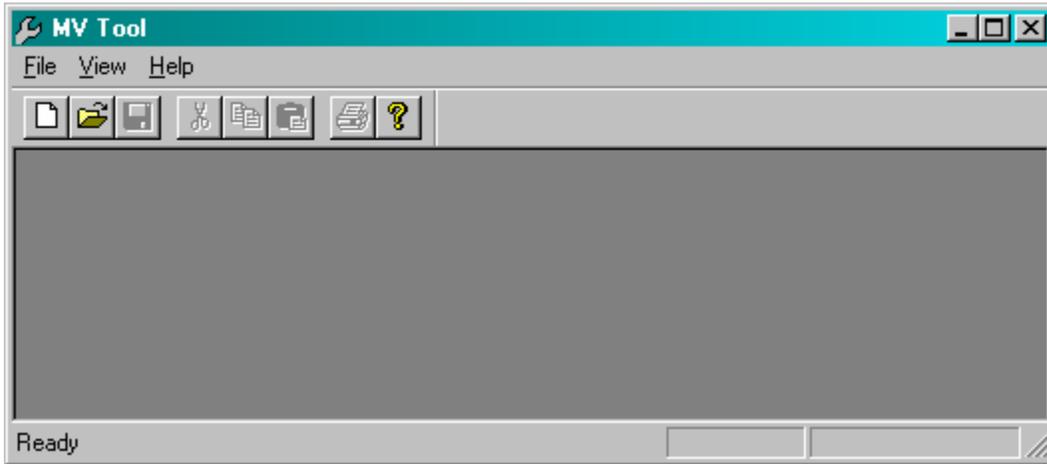
As shown in the screen shot below, once any image is displayed, the full menu is made available to the user. With a few exceptions noted in later in this document, the user options will operate on the image that is selected (topmost child window).
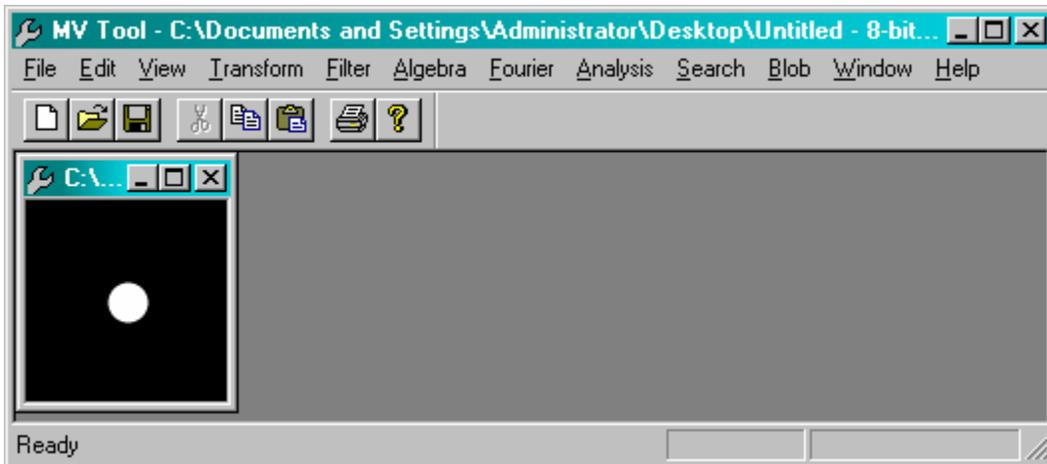
Regions of interest in an image may be "selected" by clicking the image and dragging the cursor over the image. A green rectangle will be updated real-time to display the region of the image selected by the user.

3) File menu

This section describes the use of the options listed in the File menu.

3.1) New

When this option is selected, the user is presented with the following dialog:
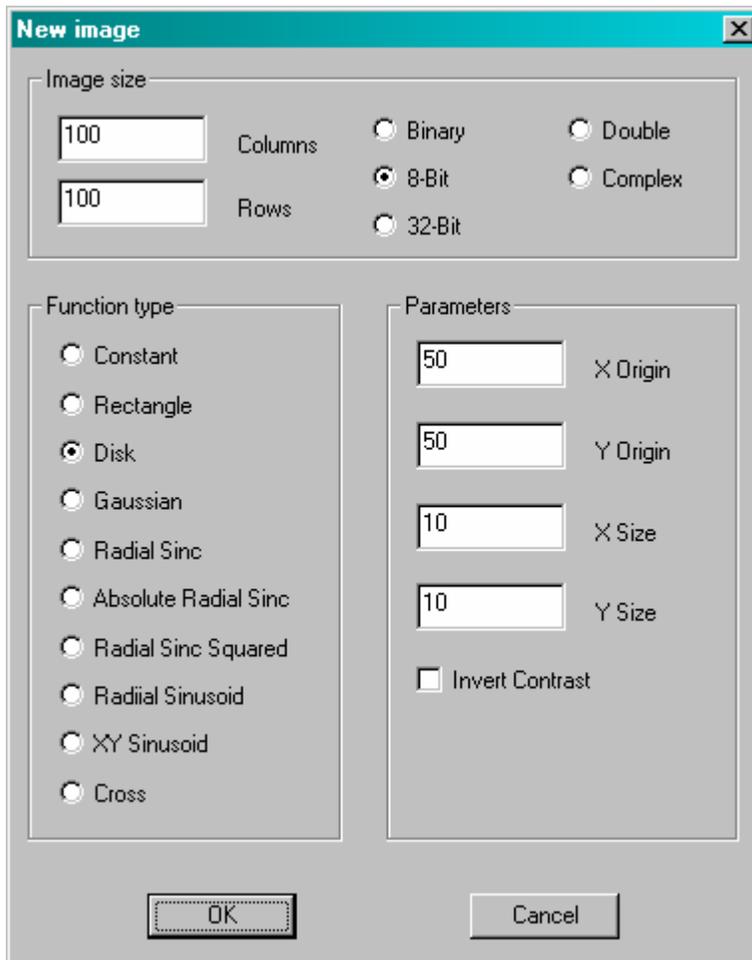
This dialog allows the user to generate an image using a variety of mathematical models. Refer to the "Image graphics" section of the MV Lib user's guide for details on the types of images that can be generated.

Once "OK" is pressed, an image will be generated using the chosen parameters and displayed in a new child window.

3.2) Duplicate

A copy of the topmost (selected) image is made and is put into a new child window where it can be processed separately from the original image.

3.3) Open

A standard Open File dialog is presented to the user. The user may select a single image file or multiple image files to open. Each image file opened is put into its own child window within the MV Tool main window.

MV Tool will use the "image I/O" functions of MV Lib to automatically determine the image file format (BMP, GIF, or MV).

If MV Tool cannot determine the file format, the user is presented with the following dialog:
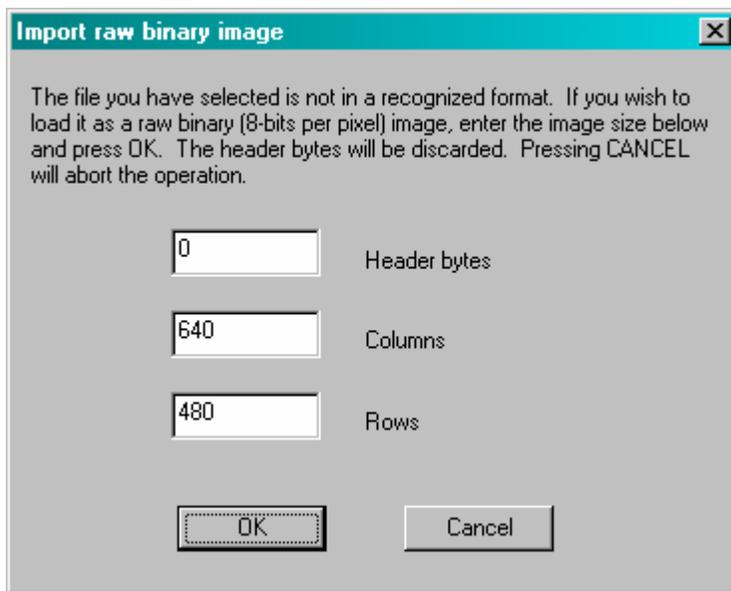
This dialog allows users to import raw 8-bit images from other sources.

3.4) Close

This will close the topmost child window.

3.5) Save

If the image path is already known, this option will save the image to the known path (overwriting the image that is already there, if any). If the path is not known, the option is ignored.

3.6) Save as

A standard Save File dialog is presented to the user. The user may select the file format (see MV Lib user's guide) by selecting an option from the "save as type" drop box. Otherwise, the file extension is used to determine if the image will be written in BMP, GIF, or MV format.

3.7) Print

This option will print the image in the topmost child window. A standard Print dialog is presented to the user. The content of this dialog will be dictated by the print driver(s) installed on the PC.

3.8) Print setup

A standard Print Setup dialog is presented to the user. The content of this dialog will be dictated by the print driver(s) installed on the PC.

3.9) Recent files

The four most recently opened files are listed at the bottom of the menu. Selecting one of these will open the image file (if it still exists) and will display the image in a new child window.

3.10) Exit

Selecting this option will cause the MV Tool application to stop running and close.

4) Edit menu

This menu is used to allow the user to do some simple editing operations on images.

4.1) Copy

Before using this option, the user must first select the region of interest (or the whole image) of the topmost child window that is to be copied.

The copy option will copy the selected region of the image to the clipboard, where it will be available to MV Tool and other applications.

Note: regardless of the image type being copied, the image copied to the clipboard will be an 8-bit monochrome image.

4.2) Paste

Before using this option, the user must first select a region of interest (or the whole image) of the topmost child window in which the paste operation is to be applied.

The paste option will copy the image from the clipboard to the selected region. If necessary, the clipboard data will be converted to the image type of the paste region.

If the paste region is smaller than the clipboard image, only the upper-left part of the clipboard image is pasted into the region (as much as will fit).

If the paste region is larger than the clipboard image, the clipboard image is pasted into the top-left corner of the paste region and the excess portion of the region is left as-is.

4.3) Paste to new

This operation will create a new child window of the same size as the image in the clipboard. The clipboard data is then pasted into the new image, completely filling it.

4.4) Select all

This option will select the entire image of the topmost child window. A green rectangle representing the selected region will appear in the child window.

4.5) Convert

MV Lib supports images of several different types (resolutions), Refer to the MV Lib user's manual for details of these image types.

This option allows the user to convert the topmost child window into a different image type.

5) View Menu

This menu is used to control the toolbar and status display.

5.1) Toolbar

The (dockable) toolbar may be enabled or disabled using this menu option.

The toolbar options mirror the menu options (from left to right): new, open, save, cut (not supported), copy, paste, print, help.

5.2) Status

The status display may be enabled or disabled using this menu option.

The status display at the bottom of the MV Tool window is used to display image coordinates and whether the user is in the region of interest selection mode or profile mode:

6) Transform menu

Transforms are used to transform an image into another one.

6.1) Scale

Selecting this option makes the following dialog appear:
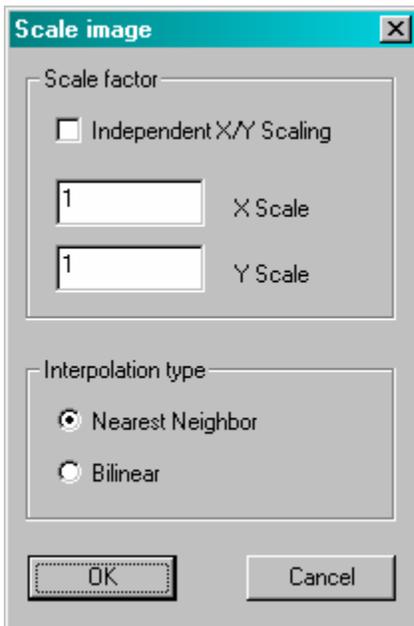
The user may select to scale the images independently in X and Y, otherwise the X scale and Y scale edit boxes will maintain the same scaling factor and the resulting image will retain the aspect ratio of the original image. Refer to the MV Lib user's guide for information regarding scaling factors and interpolation types.

When OK is pressed, the image in the topmost child window is scaled per the parameters entered into the dialog box and the new scaled image replaces the original image in the child window.

6.2) Scale to fit

Selecting this option makes the following dialog appear:
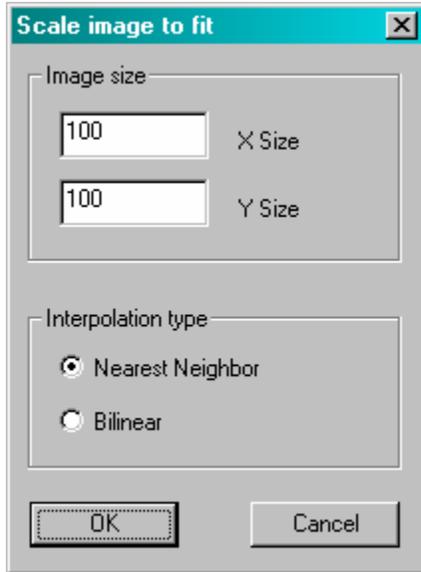
This is similar to the scale option except the user can select the exact size (in pixels) that the image will be scaled to.

When OK is pressed, the image in the topmost child window is scaled per the parameters entered into the dialog box and the new scaled image replaces the original image in the child window.

6.3) Subsample

Selecting this option makes the following dialog appear:
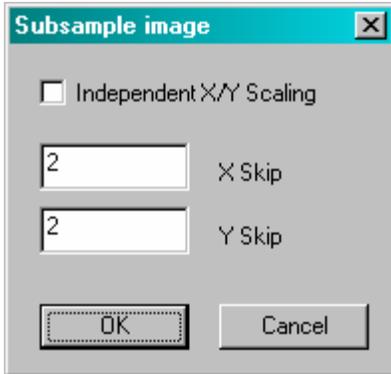
This is an alternative form of scaling in which the image is scaled down in size by subsampling (skipping) pixels at the user selected rates.

When OK is pressed, the image in the topmost child window is subsampled per the parameters entered into the dialog box and the new subsampled image replaces the original image in the child window.

6.4) Rotate

Selecting this option makes the following dialog appear:

This option allows the user to rotate an image about its center by the specified angle. Refer to the MV Lib user's guide for information regarding image rotation.

When OK is pressed, the image in the topmost child window is rotated per the parameters entered into the dialog box and the new rotated image replaces the original image in the child window.

6.5) Transpose

When this option is selected, the image in the topmost child window is transposed and the new transposed image replaces the original image in the child window.

6.6) Mirror

Selecting this option makes the following dialog appear:

Mirror image

○ Mirror about Y (vertical) axis
○ Mirror about X (horizontal) axis

[OK]   [Cancel]

When OK is pressed, the image in the topmost child window is mirrored about the axis specified by the user. The new mirrored image replaces the original image in the child window.

6.7) Geometric
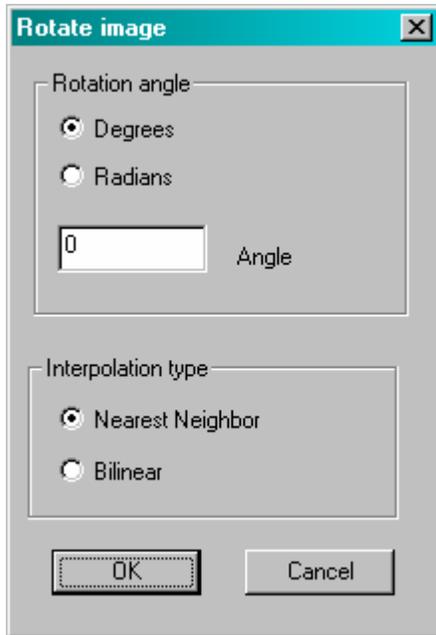
Selecting this option makes the following dialog appear:

Geometric transform

$X^* =$ [1] $X +$ [0] $Y +$ [0]

$Y^* =$ [0] $X +$ [1] $Y +$ [0]

[OK]   [Cancel]
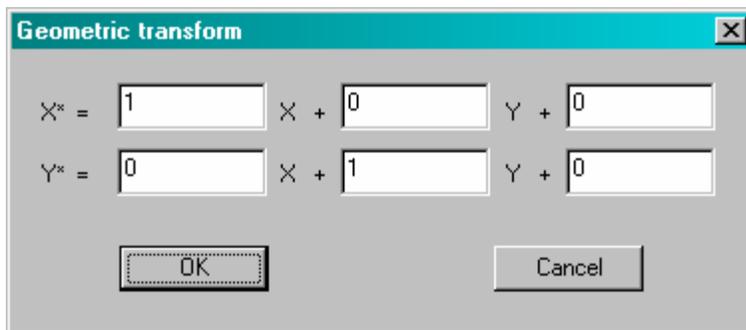
Refer to the MV Lib user's guides for details on geometric transforms. The user may define a geometric transform by entering the desired parameters into the dialog box.

When OK is pressed, the image in the topmost child window is transformed according to the parameters entered into the dialog box. The new transformed image replaces the original image in the child window.

6.8) Linear stretch

When this option is selected, a linear contrast stretch is performed on the image in the topmost child window. The new image replaces the original image in the child window.

6.9) Equalize

When this option is selected, a histogram equalization is performed on the image in the topmost child window. The new image replaces the original image in the child window.

6.10) Negate

When this option is selected, a negation is performed on the image in the topmost child window. The new image replaces the original image in the child window.

6.11) Binary threshold

Selecting this option makes the following dialog appear:
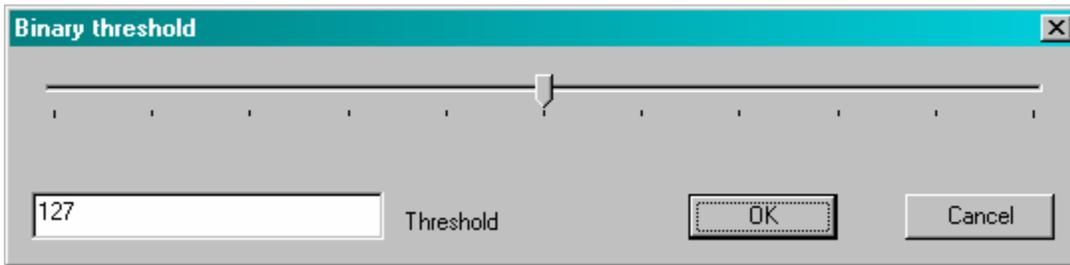

The user may adjust the threshold via the edit box or the slider and view the binary threshold results real-time.

When OK is pressed, the image in the topmost child window is binarized according to the threshold entered into the dialog box. The new binary image replaces the original image in the child window.

If cancel is pressed, the image returns to it original state.

6.12) Pixel map

Selecting this option makes the following dialog appear:
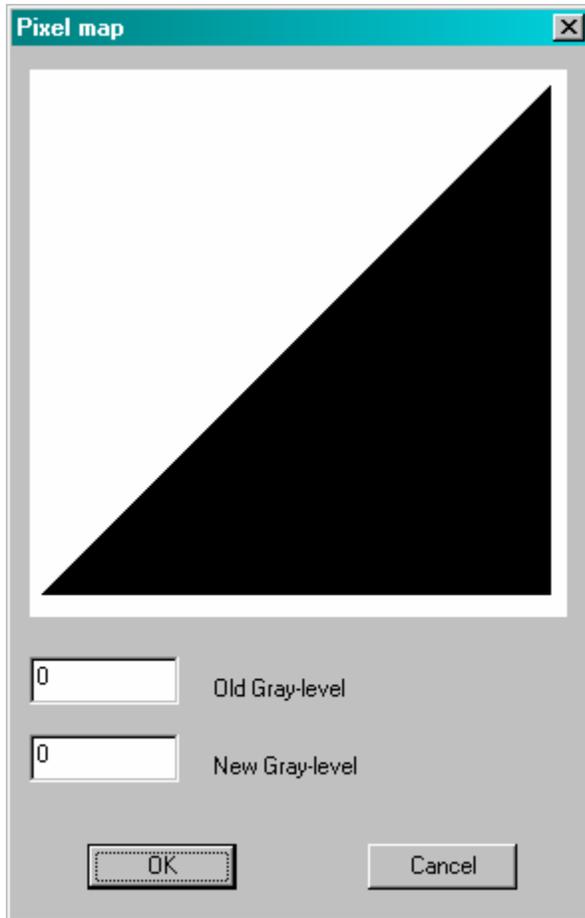
The user may manually enter (old pixel, new pixel) data pairs via the edit boxes, or by clicking on the map area, the map will change, real-time, as the cursor is moved across the map area of the dialog box.

When OK is pressed, the image in the topmost child window is mapped according to the pixel map entered into the dialog box. The newly mapped image replaces the original image in the child window.

If cancel is pressed, the image returns to it original state.

6.13) Dither
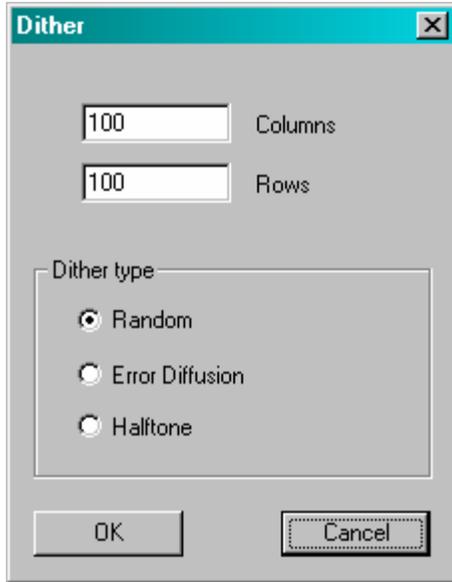
Selecting this option makes the following dialog appear:

The user selects the size of the dithered image and the type of dithering algorithm. When OK is pressed these parameters are used, along with the image in the topmost child window, to create a dithered image. The new (binary) dithered image is placed into its own child window. The original image is left as-is.

6.14) Add noise

This menu item has three sub-menu selections, detailed in the sub-sections below. Refer to the MV Lib user's guide for details of how these noise generator algorithms operate.

6.14.1) Salt and pepper noise

Selecting this option makes the following dialog appear:
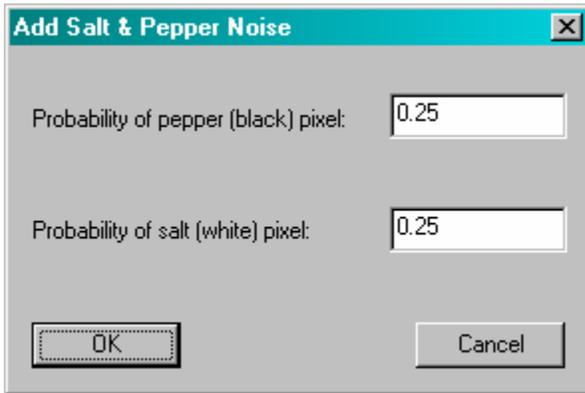
The user must select the probability of white and dark pixels occurring. When OK is pressed, salt and pepper noise is added to the image in the topmost child window.

6.14.2) Uniform noise

Selecting this option makes the corresponding dialog appear:
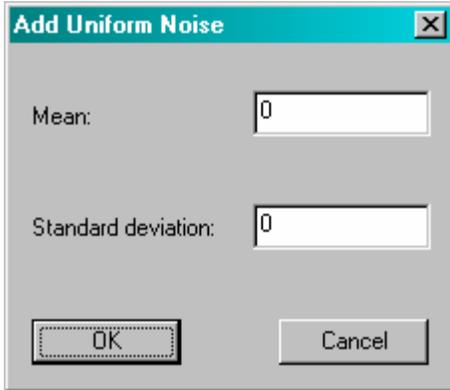
The user must select the mean and standard deviation of the uniform noise function.
When OK is pressed, uniform noise is added to the image in the topmost child window.

6.14.2) Gaussian noise

Selecting this option makes the corresponding dialog appear:
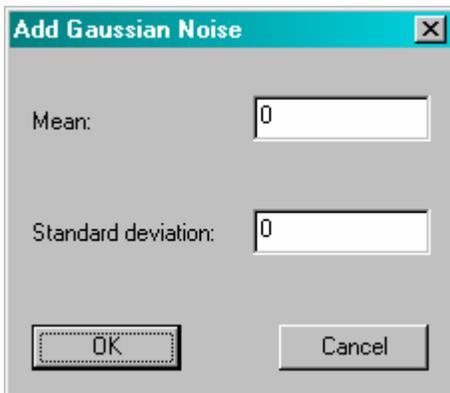
The user must select the mean and standard deviation of the Gaussian noise function.
When OK is pressed, Gaussian noise is added to the image in the topmost child window.

7) Filter menu

The options in this menu allow the user to perform filtering operations on images.

7.1) Average

Selecting this option makes the following dialog appear:
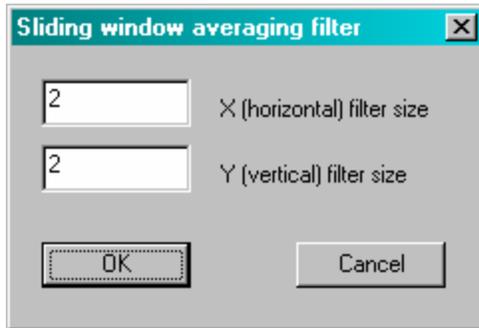
The user must enter the desired window size of the averaging filter.

Pressing OK will cause the image in the topmost child window to be filtered with the averaging filter of the specified size. The original image is replaced with the filtered one.

7.2) Median

Selecting this option makes the following dialog appear:

The user must enter the desired window size of the median filter.

Pressing OK will cause the image in the topmost child window to be filtered with the median filter of the specified size. The original image is replaced with the filtered one.

7.3) Max

Selecting this option makes the following dialog appear:

The user must enter the desired window size of the max filter.

Pressing OK will cause the image in the topmost child window to be filtered with the max filter of the specified size. The original image is replaced with the filtered one.

7.4) Min
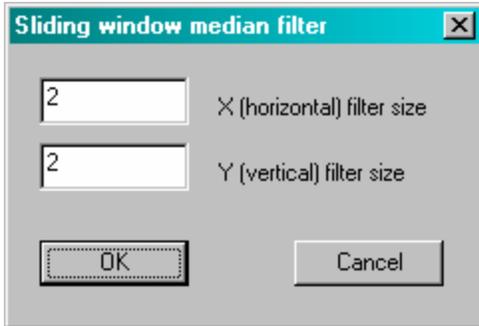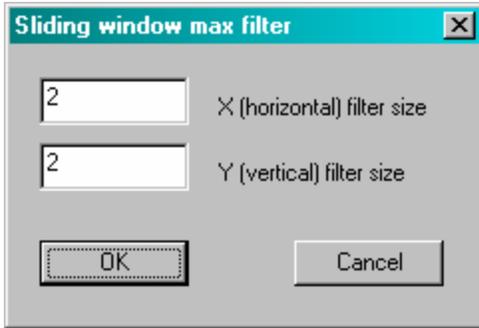
Selecting this option makes the following dialog appear:
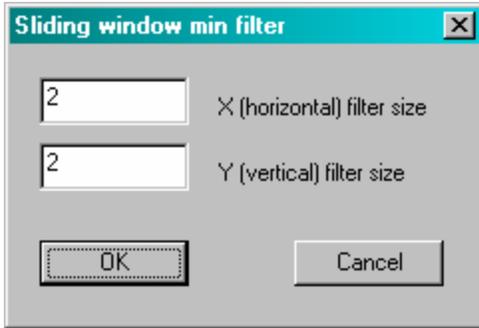
The user must enter the desired window size of the min filter.

Pressing OK will cause the image in the topmost child window to be filtered with the min filter of the specified size. The original image is replaced with the filtered one.

7.5) Small template

This menu option has a sub-menu with three options detailed in the subsections below.

7.5.1) Sobel magnitude

When this option is selected, a Sobel gradient magnitude filter is run on the image in the topmost child window. The original image is replaced with the filtered one.

7.5.2) Sobel orientation

When this option is selected, a Sobel gradient orientation filter is run on the image in the topmost child window. The original image is replaced with the filtered one.

7.5.3) Laplacian

When this option is selected, a Laplacian filter is run on the image in the topmost child window. The original image is replaced with the filtered one.

7.6) User-defined template

Selecting this option makes the following dialog appear:
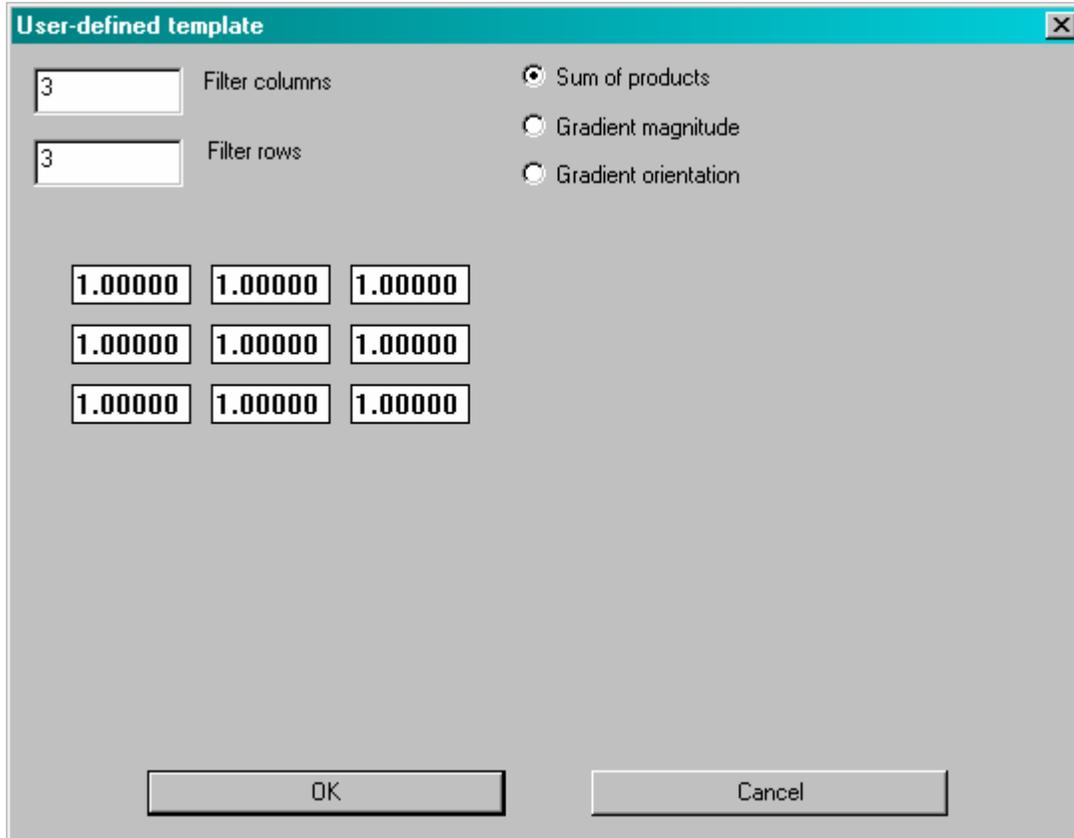
By changing the filter columns and rows edit boxes, the number of filter coefficient edit boxes will change (up to 7x7). The user may also define the type of filtering process to be performed (sum of products, gradient magnitude, gradient orientation). Once the filter size and operation have been selected, the user must enter the filter coefficients into the coefficient edit boxes.

Pressing OK will cause the image in the topmost child window to be filtered with the specified filter. The original image is replaced with the filtered one.

8) Algebra menu

Selecting any of the image algebra options will cause a dialog box similar to the one below to be displayed:
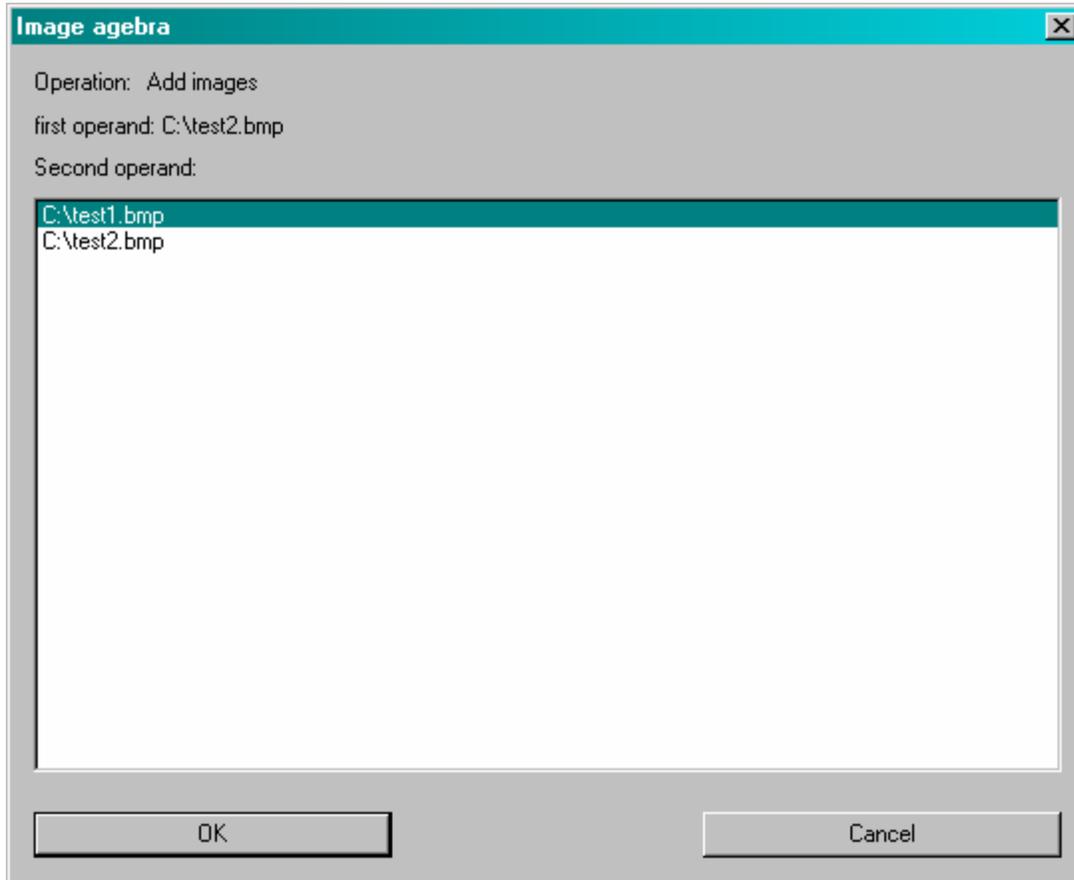
The user must select an image from the list of currently opened images displayed in the dialog. The selected image must be of the same size and type as the image in the topmost child window. When OK is pressed, the image is processed according to the menu option as described below.

8.1) Add

Selecting this option adds the selected image to the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.2) Subtract

Selecting this option subtracts the selected image from the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.3) Multiply

Selecting this option multiplies the selected image by the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.4) Divide

Selecting this option divides the selected image into the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.5) And

Selecting this option logically ANDs the selected image with the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.6) Or

Selecting this option logically ORs the selected image with the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.7) Xor

Selecting this option logically XORs the selected image with the image in the topmost child window. The resulting image replaces the one in the topmost child window.

8.8) Max

Each pixel of the selected image is compared to the corresponding pixel in the image in the topmost child window. The greater of the two pixels values is chosen for the resulting image. The resulting image replaces the one in the topmost child window.

8.9) Min

Each pixel of the selected image is compared to the corresponding pixel in the image in the topmost child window. The lesser of the two pixels values is chosen for the resulting image. The resulting image replaces the one in the topmost child window.

9) Fourier menu

2-D Fourier transforms can be performed on images. They can be used to better understand the frequency content of an image.

9.1) Forward transform

Selecting this option will cause a forward Fourier transform to be run on the image in the topmost child window. The Fourier transform of the image replaces the image in the child window. As with all complex images, only the real component is displayed in the child window.

9.2) Inverse transform

Selecting this option will cause an inverse Fourier transform to be run on the image in the topmost child window. The Fourier transform of the image replaces the image in the child window. As with all complex images, only the real component is displayed in the child window.

9.3) Magnitude

This option will only work on complex images. Selecting this option will cause the magnitude of each complex pixel to be computed for the image in the topmost child window. The resulting image then replaces the one in the child image.

9.4) Phase

This option will only work on complex images. Selecting this option will cause the phase of each complex pixel to be computed for the image in the topmost child window. The resulting image then replaces the one in the child image.

10) Analysis menu

This menu holds some basic image analysis options.

10.1) Statistics

When selected, the image in the topmost child window is analyzed and its statistics are presented to the user in a dialog like the example shown below:
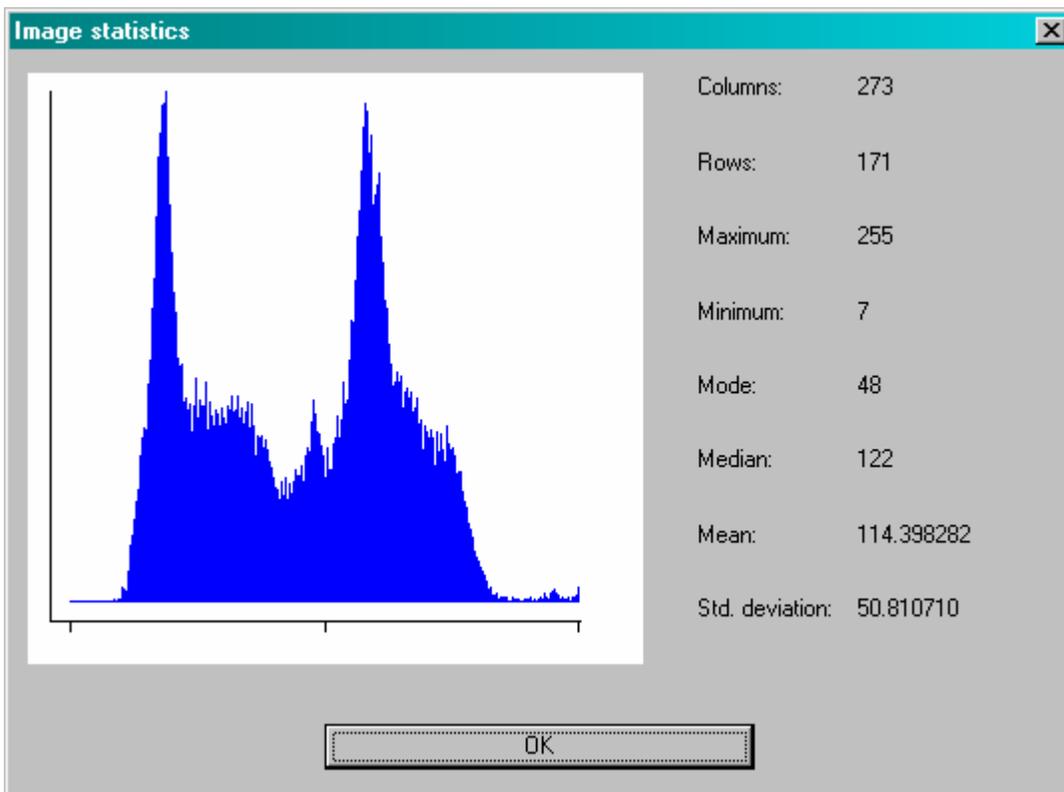
Note: the histogram is only displayed for binary and 8-bit images.

10.2) Scene angle

The user may choose from unidirectional or bidirectional scene angle analysis. In either case the image in the topmost child window is analyzed and a dialog like the one in the example below is displayed:
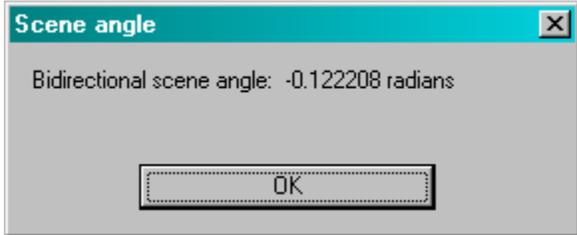
As well, lines are overlaid onto the image in the child window in order to illustrate the scene angle found. The image itself is left unchanged.

10.3) Projection

Sub-menus allow the user to choose from projection onto the X axis, projection onto the Y axis, or projection at an arbitrary angle. In the case of projection onto an arbitrary angle, the user must enter the angle in the following dialog:
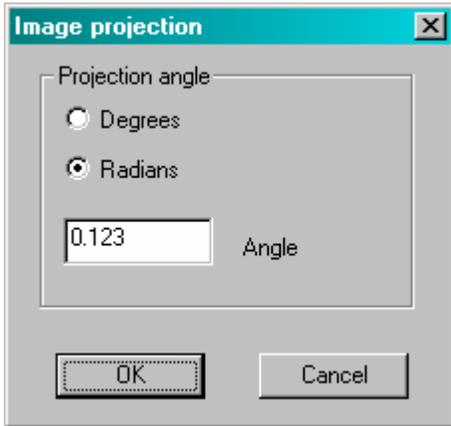
In any event, once the type of projection is chosen, the image in the topmost child window is projected onto the chosen axis. The resulting projection is displayed in a separate window, such as the one shown in the example below:
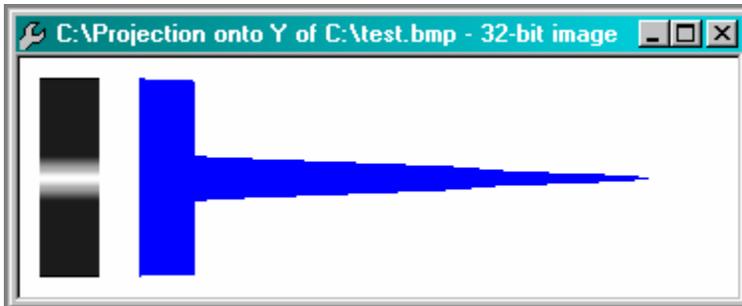
10.4) Profile

When the user selects the profile option, MV Tool is put into the profile state. This state is displayed in the status bar. When a user clicks on an image and drags the cursor over the image, a line from the starting point to the current cursor point is drawn and updated real-time as the cursor is moved. Releasing the cursor causes all image pixels "under" the line to be gather and displayed in a separate window. This user-selected 1-D slice of the image is the "profile" (see example below):
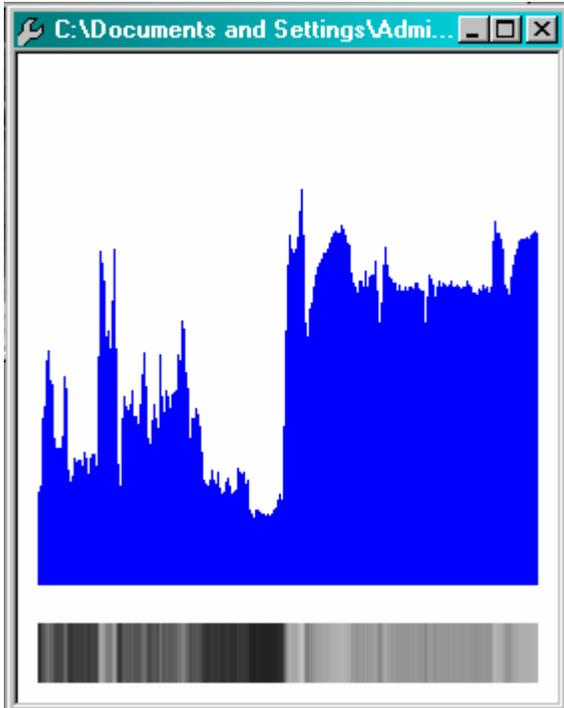
Once the profile is complete, MV Tool returns to the normal mode allowing rectangular regions of interest to be selected with the cursor.

10.5) Perspective plot

Before selecting this option, the user must select a region of interest in the desired image window. Once this option is selected, a new window is created and displays the pixels in the region of interest as a 3-D "perspective plot". An example is shown below:
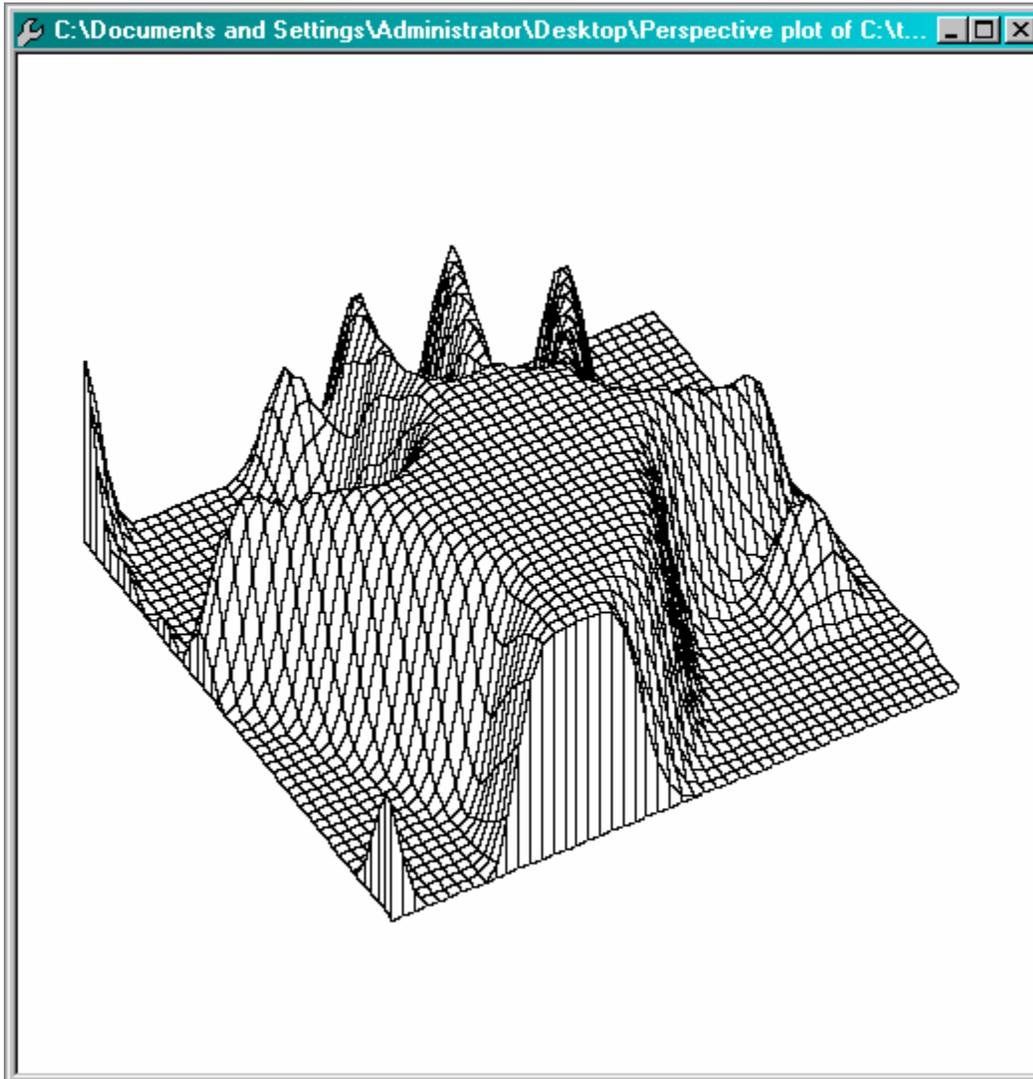
Note: regions of interest over 50x50 pixels are scaled to a maximum of 50 pixels in either dimension. This perspective plot is itself an image and may be saved and loaded just as any other image can be.

11) Search menu

The search menu is used to allow users to access the normalized correlation search (NCS) and fiducial localization functionality of MV Lib.

11.1) Train

Before selecting this function, the user must have already selected a region of interest within an image of no more the 256x256 pixels. Once this option is selected, a NCS model is trained and held internally.

11.2) Search, normalized correlation

In order to use this option, the user must first "train" a model by using the train option. Once selected, a search for the previously trained model is conducted on the image in the topmost child window. The location of the target found is displayed on the image and the coordinates and normalized correlation score are displayed in a dialog box like the example shown below:
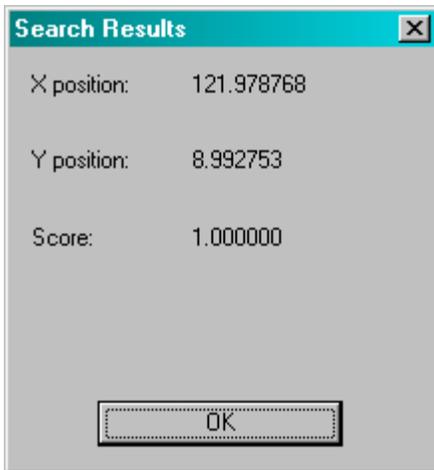
11.3) Search, normalized correlation options

By selecting this option, the following dialog is presented to the user. The parameters used to search for a model in an image can then be edited. When OK is pressed, the parameters are stored internally and are applied to all subsequent searches (see section 11.2).

11.4) Localize fiducial

Before selecting this option, the user must first select a region of interest in the image that is to have a fiducial localized. Once the region of interest has been selected, the user can choose to localize the fiducial in X, Y, or Both by selecting the appropriate sub-menu option.

Once selected, a search for the fiducial is conducted on the image in the topmost child window. The location of the fiducial is displayed on the image and the coordinates and normalized auto-convolution scores are displayed in a dialog box like the example shown below:
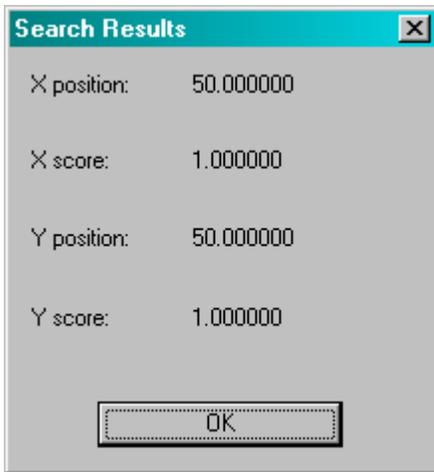
12) Blob menu

Binary and watershed segmentation (blob finding) algorithms can be run through this menu.

12.1) Binary

Selecting this option will allow the user to run a connectivity analysis on a binary image. The user can set parameters to restrict the size and number of blobs found using the following dialog box:
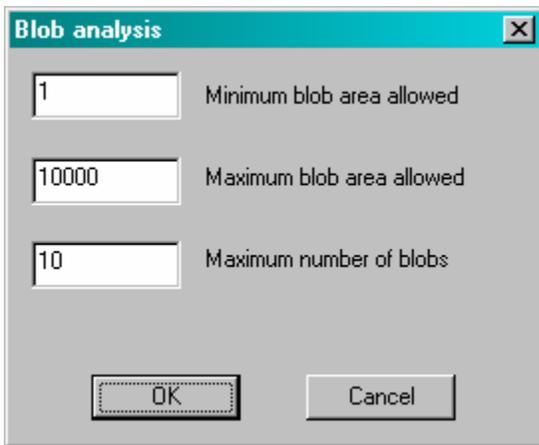
Once OK is pressed, a connectivity analysis is run on the image in the topmost child window, using the user-specified parameters. The result will be a dialog box similar to the one shown in the example below:

```
Blob analysis results                                                    ⊠

 8 BLOBS FOUND


 BLOB 1:          area = 415      min X,Y = 55 , 24    max X,Y = 76 , 45
 BLOB 2:          area = 415      min X,Y = 24 , 55    max X,Y = 45 , 76
 BLOB 3:          area = 280      min X,Y = 24 , 0     max X,Y = 45 , 13
 BLOB 4:          area = 280      min X,Y = 0 , 24     max X,Y = 13 , 45
 BLOB 5:          area = 258      min X,Y = 55 , 87    max X,Y = 76 , 99
 BLOB 6:          area = 258      min X,Y = 87 , 55    max X,Y = 99 , 76
 BLOB 7:          area = 170      min X,Y = 0 , 87     max X,Y = 13 , 99
 BLOB 8:          area = 170      min X,Y = 87 , 0     max X,Y = 99 , 13




 centroid X,Y = 65.689157 , 34.310843



                          [         OK         ]
```
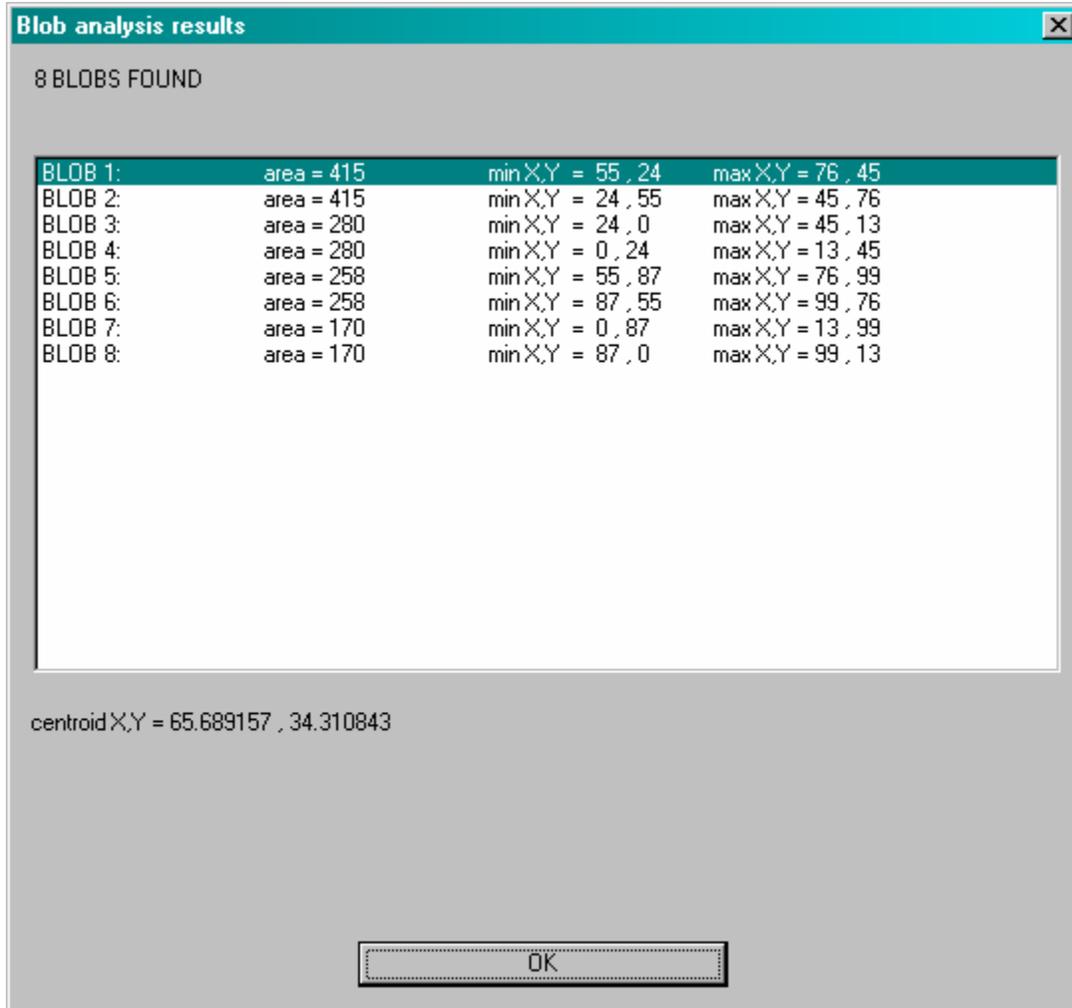
In addition, the blobs found are highlighted in the child window holding the image. All blobs found are shown in red, except the one selected in the above dialog box, which is shown in green. By selecting a blob in the list, the user can see where the blob appears in the image. The image itself is not changed.

12.2) Watershed

Selecting this option will allow the user to run a watershed analysis on a 8-bit image. The user can set parameters to restrict the size and number of blobs found using the same dialog box as used for connectivity analysis (see section 12.1).

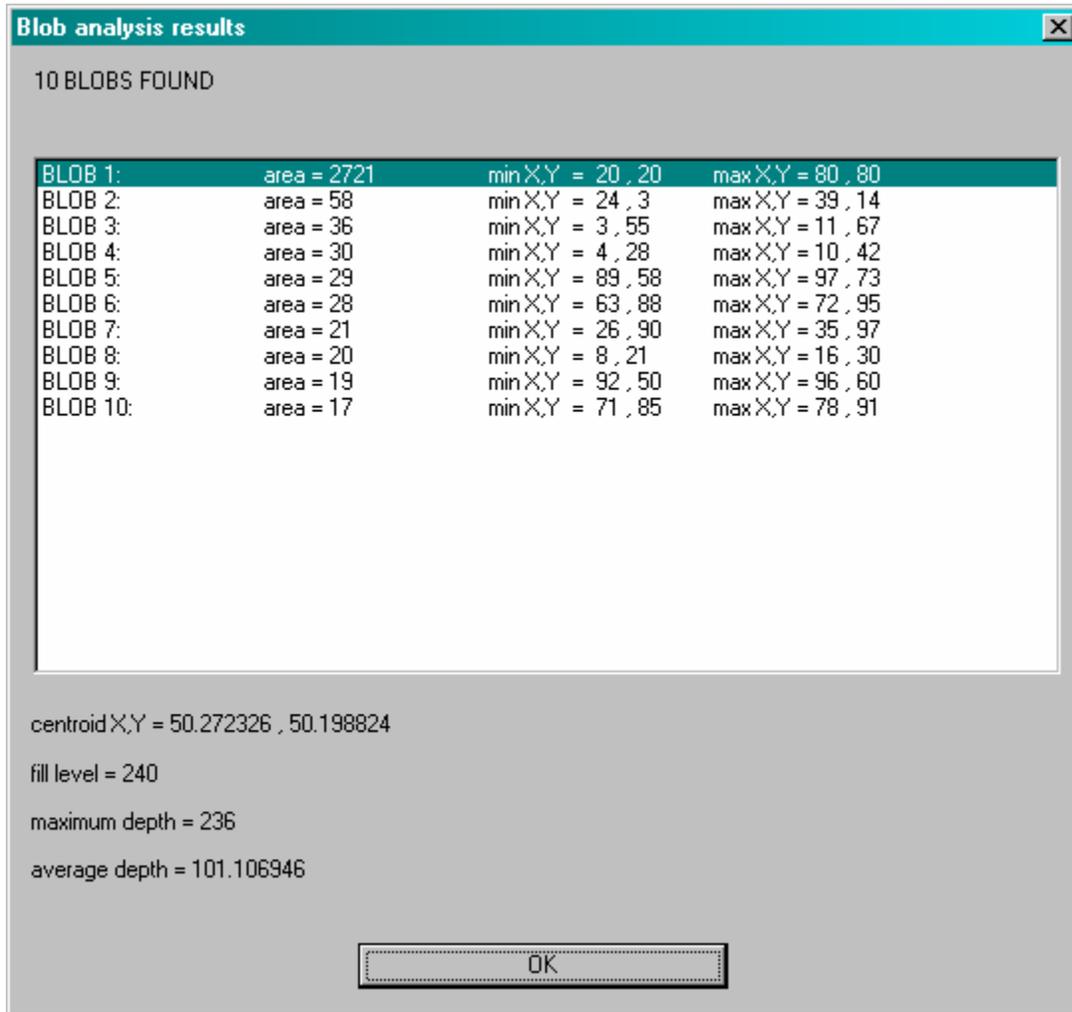Once OK is pressed, a watershed analysis is run on the image in the topmost child window, using the user-specified parameters. The result will be a dialog box similar to the one shown in the example below:

```
Blob analysis results                                        [X]

   10 BLOBS FOUND

   BLOB 1:        area = 2721    min X,Y  =  20 , 20    max X,Y = 80 , 80
   BLOB 2:        area = 58      min X,Y  =  24 , 3     max X,Y = 39 , 14
   BLOB 3:        area = 36      min X,Y  =  3 , 55     max X,Y = 11 , 67
   BLOB 4:        area = 30      min X,Y  =  4 , 28     max X,Y = 10 , 42
   BLOB 5:        area = 29      min X,Y  =  89 , 58    max X,Y = 97 , 73
   BLOB 6:        area = 28      min X,Y  =  63 , 88    max X,Y = 72 , 95
   BLOB 7:        area = 21      min X,Y  =  26 , 90    max X,Y = 35 , 97
   BLOB 8:        area = 20      min X,Y  =  8 , 21     max X,Y = 16 , 30
   BLOB 9:        area = 19      min X,Y  =  92 , 50    max X,Y = 96 , 60
   BLOB 10:       area = 17      min X,Y  =  71 , 85    max X,Y = 78 , 91


   centroid X,Y = 50.272326 , 50.198824

   fill level = 240

   maximum depth = 236

   average depth = 101.106946

                        [      OK      ]
```

This is the same dialog as used for connectivity analysis (see section 12.1) except that some additional information specific to watershed analysis is displayed (refer to MV Lib user's guide).

13) Window menu

The Window menu contains four commonly used options for organizing and finding the child windows.

13.1) Cascade

Selecting this option causes the open child windows to be arranged in "cascade" order.

13.2) Tile

Selecting this option causes the open child windows to be arranged in "tiled" order.

13.3) Arrange icons

Selecting this option causes the minimized child windows to be arranged at the bottom of the main MV Tool window.

13.4) Images displayed

All child window titles (image path names) are displayed at the bottom of the menu, with a check mark beside the topmost child window.

Selecting one of the listed images will select it and make it the topmost child window. If the selected window is minimized, it will be restored as it is brought to the front of the window order.

14) Help menu

Currently the Help menu has one option, detailed below:

14.1) About MV Tool

Selecting this option causes the following dialog to be displayed, from which the user can determine the version of the MV Tool program.