10 Changing Image Datasets Using MIPAV Utilities

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Standard tasks provided through commands on the Utilities menu

MIPAV provides a number of utilities that you can use to perform standard image-processing tasks such as converting image datasets to another image type, transforming images by copying, cropping, or rotating them, and changing image datasets by adding, removing, or reordering slices. To perform more complex tasks, MIPAV provides algorithms, which are covered in Volume 2 of the *User's Guide*. This chapter explores the standard tasks.

To access the standard image-processing tasks, you use the commands (refer to Table 3) on the Utilities menu in the MIPAV window.

Table 3. Standard tasks provided through commands on the Utilities menu in the MIPAV window

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
4D							
"Converting 3D to 4D images and vise versa"	Convert 3D to 4D	N	Y	N	N	Y	N
	Convert 4D to 3D	N	N	Y	N	N	Y
"Convert 4D to RGB"	Convert 4D to RGB	N	N	Y	N	Y	Y
"Extracting 3D subset from 4D"	Extracting 3D Subset from 4D	N	N	Y	N	N	Y
"Removing time volumes"	Remove Time Volumes	N	N	Y	N	N	Y
"Swapping the third and fourth dimensions"	Swap DIMS 3 <-> 4	N	N	Y	N	N	Y
"Adding image margins"	Add Image Margins	Y	Y	Y	Y	Y	Y
Copying images	Clone (copy)	Y	Y	Y	Y	Y	Y

*Scalar includes the following image types: boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Table 3. Standard tasks provided through commands on the Utilities menu in the MIPAV window

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
Conversion Tools							
"Converting image datasets to different data types"	Convert Type	Y	Y	Y	N	N	N
"Converting grayscale images to RGB images"	Grays to RGB	Y	Y	Y	N	N	N
"Converting RGB datasets to grayscale datasets"	RGB to Gray RGB to Grays RGB to HSB	N	N	N	Y	Y	Y
"Correcting image spacing"	Correct Image Spacing	N	Y	Y	N	N	N
"Cropping images"	Crop Using Parameters Crop using VOI	Y	Y	Y	Y	Y	Y
"Masking (filling) images"	Fill Image	Y	Y	N	Y	Y	N
"Flipping images"							
	Flip > Horizontal	Y	Y	Y	Y	Y	Y
	Flip > Vertical	Y	Y	Y	Y	Y	Y
	Flip>In Depth (invert slice order)	N	Y	Y	N	Y	Y
"Image Calculator"	Image Calculator	Y	Y	Y	Y	Y	Y
"Image Math"	Image Math	Y	Y	Y	Y	Y	Y
"Inverting the image"	Invert	Y	Y	Y	Y	Y	Y
"Matching images"	Match Images	Y	Y	N	Y	Y	N
"Adding noise to images"	Noise	Y	Y	N	Y	Y	N

*Scalar includes the following image types: boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Table 3. Standard tasks provided through commands on the Utilities menu in the MIPAV window

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
"Pad"	Pad	Y	Y	N	Y	Y	N
"Quantify Mask"	Quantify Using Mask Quantify Mask(s)	Y	Y	Y	N	N	N
"Replacing pixel/voxel value in images"	Replace Pixe/Voxel Value	Y	Y	Y	Y	Y	Y
"Rotating images"	Rotate -> X axis +90	Y	Y	Y	Y	Y	Y
	Rotate -> X axis -90						
	Rotate.> Y axis -90	Y	Y	Y	Y	Y	Y
	Rotate -> Y axis +90	Y	Y	Y	Y	Y	Y
	Rotate -> Z axis +90	Y	Y	Y	Y	Y	Y
	Rotate -> Z axis -90	Y	Y	Y	Y	Y	Y
Slice Tools							
"Concatenating images"	Concatenate	Y	Y	Y	Y	Y	Y
"Extracting slices/ volumes"	Extract Slices/ Volumes	N	Y	Y	N	Y	Y
"Insert Missing Slices"	Insert Missing Slices	N	Y	Y	N	Y	Y
"Inserting slices into image datasets"	Insert Slice	N	Y	Y	N	Y	Y
"Pad slices to power of 2"	Pad Slices to power of 2	N	Y	Y	N	N	N

*Scalar includes the following image types: boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Table 3. Standard tasks provided through commands on the Utilities menu in the MIPAV window

Task	Command	Scalar*			RGB		
		2D	3D	4D	2D	3D	4D
"Randomizing image (slice) order"	Randomize Slice Order	N	Y	Y	N	Y	Y
"Removing images (slices) from datasets"	Remove Slices	N	Y	Y	N	Y	Y
"Replace blanks with averages"	Replace blanks with averages	N	Y	Y	N	N	N
"Replace Slices"	Replace Slices	N	Y	Y	N	Y	Y
"Subtract VOI Background"	Subtract VOI background	Y	Y	Y	Y	Y	Y

*Scalar includes the following image types: boolean, byte, unsigned byte, short, unsigned short, integer, long, float, and double.

Recording utilities usage with the history feature

MIPAV provides a way for you to record the actions, whether with algorithms or utilities, that you perform on images. You use the MIPAV Options dialog box to turn this feature on. Refer to "Saving a history of actions on images (TBD)" on page 124 in Chapter 3,"Getting Started Quickly with MIPAV" of this *User's Guide* for more information.

4 D tools

Converting 3D to 4D images and vise versa

To convert 3D images to 4D images

1. Open a 3D image or image dataset.
2. Select Utilities > Convert 3D to 4D. The Convert 3D to 4D dialog box opens.
3. Do either of the following in the Number of slices in the 3rd dimension, Resolutions: 3rd dimension, and Resolutions: 4th dimension boxes:
   - Accept the default numbers.
   - Enter different numbers.
4. Select in each of the Resolution units: 3rd dimension and Resolutions units: 4th dimension lists one of the following: millimeters (the default value), unknown, inches, centimeters, angstroms, nanometers, micrometers, milliliters, meters, kilometers, miles, nanoseconds, microseconds, milliseconds, seconds, minutes, hours, or Hz.
5. Click OK. The program applies all of the specification in this dialog box to the image or image dataset. See Figure 215 on page 385.

Number of slices in the 3rd dimension	Specifies how many slices are in the 3rd dimension. The default number is 2.
Resolutions: 3rd dimension	Indicates the resolution for the third dimension. The default number is 5.0.
Resolutions: 4th dimension	Indicates the resolution for the fourth dimension. The default number is 1.0.
Resolution units: 3rd dimension	Indicates the voxel resolution in the 3rd dimension.

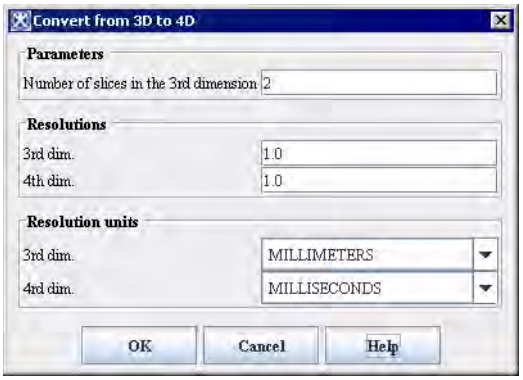


Figure 215. Convert from 3D to 4D dialog box

Resolution units: 4th dimension	Indicates the voxel resolution of the 4th dimension.
OK	Applies the specified parameters to convert a 3D image to a 4D image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not convert the image.
Help	Displays online help for this dialog box.

Figure 215. Convert from 3D to 4D dialog box (continued)

TO CONVERT 4D TO 3D IMAGES

1. Open a 4D image or image dataset.
2. Select Utilities > Convert 4D to 3D.

   The program immediately begins processing the image.

EXTRACTING 3D SUBSET FROM 4D

This utility allows you to remove one of the *x*, *y*, *z*, or *t* dimensions from 4D images to produce a 3D image. Refer to Figure 216 on page 388.

To remove an *X* dimension slice

1. Open a 4D image.
2. Select Utilities >4D Tools> Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 216) opens.
3. Select X.
4. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
5. Click Remove. The program removes the slice you specified from the dataset.

To remove a *Y* dimension slice

1. Open a 4D image.
2. Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 216) opens.
3. Select Y.
4. Type the index number of the slice you want to extract in the **Select index from <*N*> to <*N*>** box.
5. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
6. Click Remove. The program removes the slice you specified from the dataset.

To remove a *Z* dimension slice

1. Open a 4D image.
2. Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 216) opens.
3. Select Z.
4. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
5. Click Remove. The program removes the slice you specified from the dataset.

To remove the *T* dimension

1. Open a 4D image.
2. Select Utilities > Extract 3D Subset from 4D. The Extract 3D Subset dialog box (Figure 216) opens.
3. Select T.
4. Type the index number of the slice you want to extract in the Select index from. <*N*> to <*N*> box.
5. Click Remove. The program removes the slice you specified from the dataset.

X	Specifies that the algorithm should remove the *X* (width) dimension.
Y	Specifies that the algorithm should remove the *Y* (height, or length) dimension.
Z	Specifies that the algorithm should remove the *Z* (depth) dimension.
T	Specifies that the *T* (time) dimension should be removed.
Index from <N> to <N>	Specifies the index number of the volume or slice that you want to extract from the dataset.
Remove	Removes the specified dimension.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not remove any dimensions.
Help	Displays online help for this dialog box.

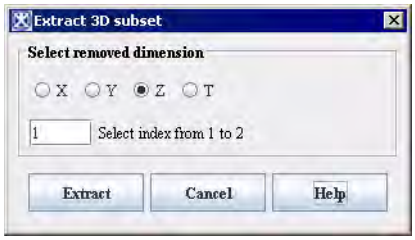


Figure 216. Extract 3D Subset dialog box

Removing time volumes

If an image dataset contains blank images or unusable images, which might be caused by patients blinking their eyes during tests, the Remove Time Volumes command on the Utility menu in the MIPAV window allows you to remove unusable images from the dataset.

To remove time volumes

1 Open an image dataset that contains time volumes.

Note: The Remove Time Volumes command only becomes active for 4D image datasets.

2 Use the image slider to look through the dataset one time volume, or image, at a time (Figure 217). If you find an unusable volume—one that is blank, or totally black, or that contains unusable information—stop moving the slider on that volume.

Note: The volume number appears in the title bar of the MIPAV window and correlates to the slice indicated by the image slider.

3. Select Utilities > Remove time volumes. The Remove Time Volumes dialog box (Figure 274 on page 464) opens.
4. Select the time volume or volumes (slices) that you want to remove in the list at the top of the dialog box, or type the number of the slice or range of volumes in the **Check the time slices to remove** box.
5. Do either of the following:
   - Click Select all to remove all of the slices.
   - Click Remove to remove the slices you selected.

   A status message appears. Then the MIPAV window refreshes.
6. Use the image slider again, if you'd like, to look through the slices in the dataset to verify that the appropriate slices were removed. See Figure 217 and Figure 218.

Swapping the third and fourth dimensions

Swapping the third and fourth dimensions refers to how image datasets are stored. Datasets may be stored using the following two methods:

- *xytz* (horizontal, vertical, time, third dimension)
- *xyzt* (horizontal, vertical, third dimension, time)

Because MIPAV requires that datasets be stored using the *xyzt* method, it provides the Swap Dims 3 <-> 4 command for those users whose datasets may be stored using the *xytz* method.

To swap the third and fourth dimensions

1. Open an image that is stored using the *xytz* method.
2. Select Utilities>4D Tools>Swap Dims 3 <-> 4. A progress message appears briefly while the program changes the storage method of the image and replaces the image with one that is stored using the *xyzt* method.

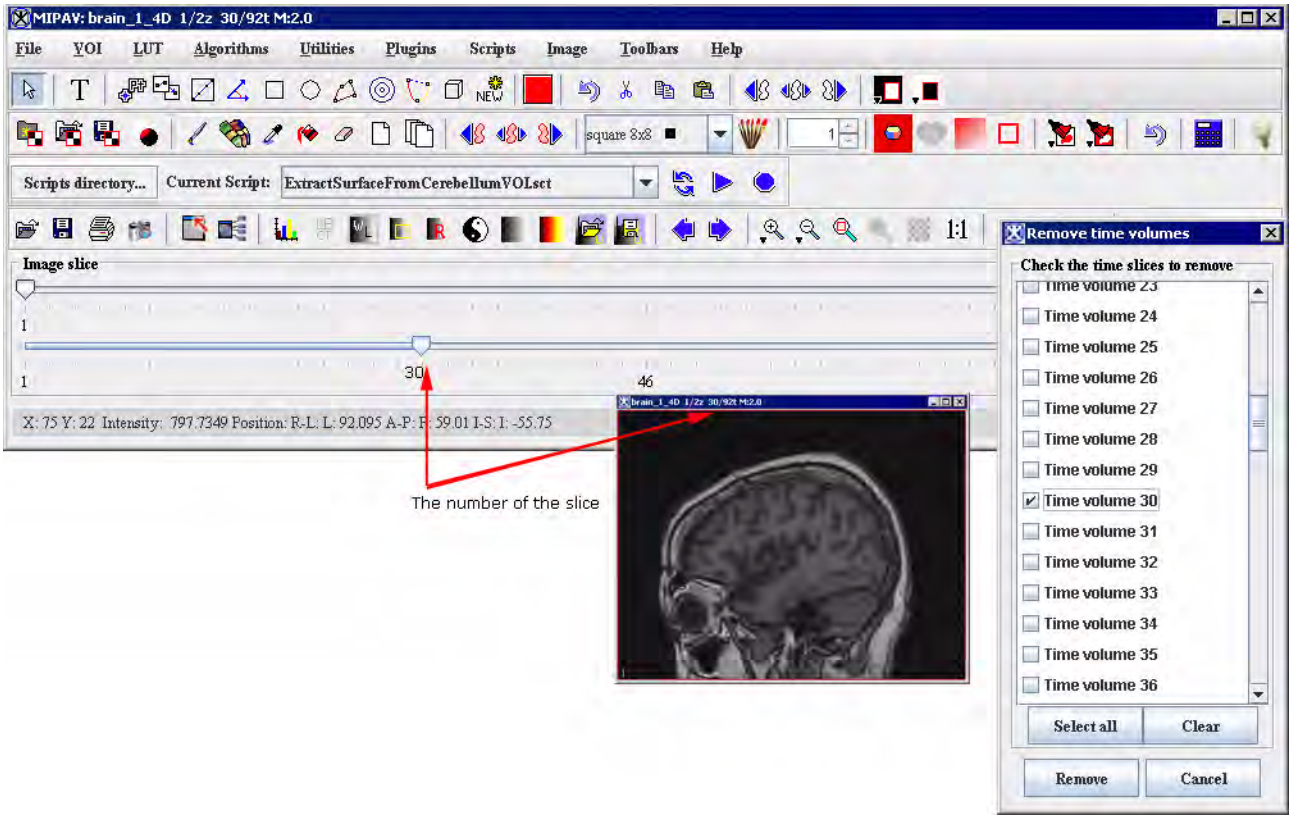


Figure 217. Using the image slider to look through an image dataset

Select all	Selects all time volumes.
Clear	Clears selection.
Remove	Removes selected slices.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not remove the time volumes.
Help	Displays online help for this dialog box.

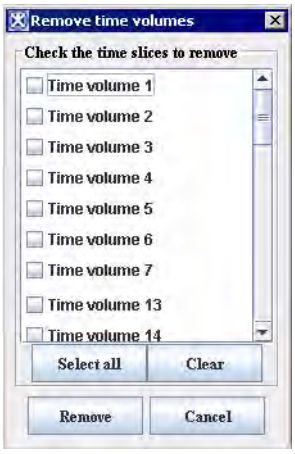


Figure 218. The Remove Time Volumes dialog box

Convert 4D to RGB

This utility converts 4D datasets that have three or less slices (volumes) into RGB 3D images, where each slice is represented by one channel – red, green or blue.

To convert 4D to 3D images

1. Open a 4D image or image dataset.
2. Select Utilities >4D Tools>Convert 4D to RGB.
3. The Convert 4D to RGB dialog box appears. Complete the dialog box, use the list boxes to assign a chosen volume to the corresponding color channel. Refer to Figure 219.
4. Press OK. The new 3D RGB image appears in a new image frame. See Figure 220.

Volume/color channel Specify the image volume and the corresponding color channel. Use the list boxes to select Red, Green, and Blue channel; or use blank.	
Remap data	Check this box, if you would like to remap RGB data to 0–255 range.
OK	Applies the specified parameters to convert a $D image to a RGB image.
Cancel	Disregards any changes you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 219. The Convert 4D to RGB dialog box

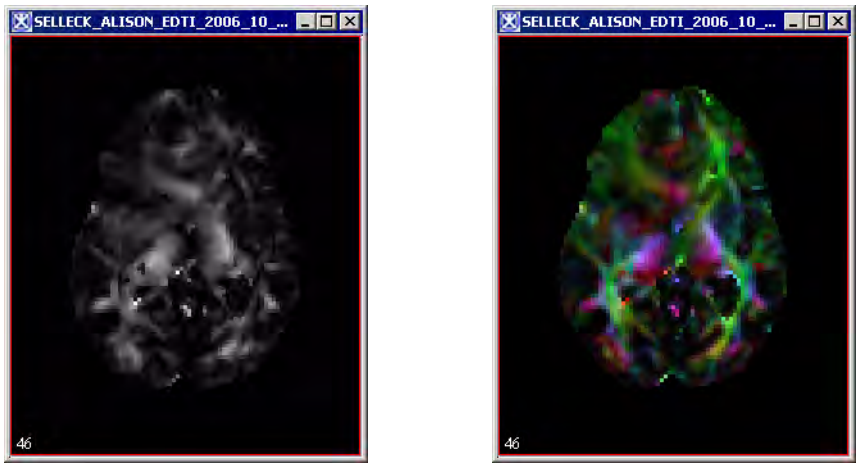


Figure 220. The original 4D image and the same image converted to 3D RGB

Adding image margins

The Add Image Margins command allows you to add a border of pixels or a specific intensity along the edges of an image dataset.

To add image margins

1. Open an image.
2. Select Utilities > Add Image Margins. The Add Image Borders dialog box (Figure 221) opens.
3. Enter the number of pixels to add on the left and right sides of the image, the top and bottom, and to the front and back of the image.
4. Enter the intensity value for the margins.
5. Select one of the following destinations:
   - *New image*—The software applies the margins to another instance of the dataset in a new image window.
   - *Replace image*—The software adds the margins to the existing instance of the dataset.
6. Click OK. The image margins are applied to the dataset.

Margins Around Image	**Pixels on the left side:** Specifies the number of pixels that should appear on the left side of the image. **Pixels on the right side:** Specifies the number of pixels that should appear on the right side of the image. **Pixels on top:** Specifies the number of pixels that should appear on the top of the image. **Pixels on bottom:** Specifies the number of pixels that should appear at the bottom of the image. **Slices at the front of image:** Specifies the number of slices that should appear at the front of the image. **Slices at the back of image:** Specifies the number of slices that should appear at the back of the image.
Value for margins	Specifies the intensity of the border around the image. As a default, the intensity of the border is the same intensity as that for the image.
New image	Shows the image with the additional or adjusted margins in a new image window.
Replace image	Replaces the current active image with the results of the image to which margins were added or adjusted.
OK	Applies the parameters that you specified to add margins to this image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not add image margins.
Help	Displays online help for this dialog box.

Figure 221. Add Image Border dialog box

Copying images using the Clone command

Suppose you need to copy an image dataset. To do so, you would use the Clone command on the Utility menu. This command generates a duplicate of the dataset and any information stored on the image, utility, algorithms, VOI, and paint layers.

Note: The Clone utility copies VOIs as well as the image, but it does not copy LUT information. Although we can observe its effects, it is not stored in an image layer.

If two datasets are loaded into one image window, only the active dataset is cloned. When the dataset is duplicated, the duplicate dataset appears in its own image window.

To copy an image dataset, you simply select Utility > Clone (copy) in the MIPAV window. In a moment or two, a duplicate of the dataset appears in a new image window.

Converting image datasets to different data types

In MIPAV you can convert image datasets to different data types. For example, you might want to convert a Boolean type dataset to an integer type dataset. MIPAV also allows you to simultaneously alter the input and output values. This utility is particularly helpful if you want to apply an algorithm to a dataset but cannot do so because the original images are the wrong image type.

data type—A set of values from which a variable, constant, function, or expression may takes its value. MIPAV automates the following data types: Boolean, signed byte, unsigned byte, signed short, unsigned short, integer, long, float, double, and color 24.

CONVERT TYPE

To convert a dataset to a different image type

1. Select Utilities >Conversion Tools > Convert type. The Convert Image Type dialog box (Figure 222) opens.
2. Select the desired image type in the Image Type group.

3 Indicate the start and end input ranges in the Range of input values group.

4 Indicate the start and end output ranges in the Range of output values group.

5 Specify either Little endian or Big endian in the Endianess group.

6 Click OK. The dataset is converted to the new image type.

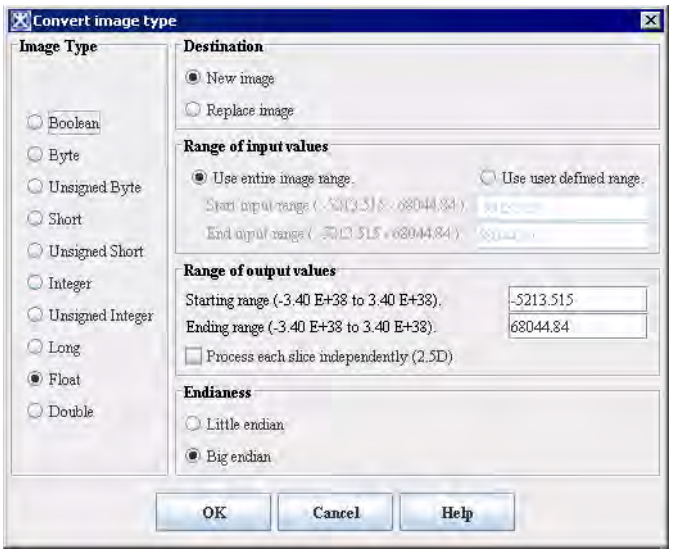


Image Type	Specifies the data type. Select one of the following:	
	Boolean	Indicates whether a condition if true or false.
	Byte	Primitive 8-bit data type. Valid values range from -127 to 128.
	Unsigned byte	Primitive 8-bit data type. Unsigned byte is a variation of the integer data type. The unsigned byte data type signifies that valid values must fall within a specified range of positive whole number values. Valid values range from 0 to 255. Negative values are not valid, hence the term *unsigned byte*.

Figure 222. Convert Image Type dialog box

	Short	Primitive 16-bit data type. Short is a variation of the integer data type. Short accommodates values that are whole numbers. Valid values range from 0 to +32,768.
	Unsigned short	Primitive 16-bit data type. Unsigned short is a variation of the integer data type. The unsigned short data type signifies that valid values must fall within a specified range of positive whole number values. Valid values range from 0 to 65,535. Note that negative values are not valid, hence the term *unsigned byte*.
	Integer	Primitive 32-bit data type. Integer is sometimes abbreviated as int. Integer accommodates values that are whole numbers. Valid values range from -2,147,483,648 to +2,147,483,648.
	Unsigned integer	Primitive 32-bit data type.
	Long	Primitive 64-bit data type. Long is a variation of the integer data type. Long accommodates values that are whole numbers. Valid values range from -9,223,372,036,854,775,808 to +9,223,372,036,854,775,808.
	Float	Primitive 32-bit data type. Float is a floating point data type that accommodates decimal values, up to 6 or 7 significant digits of accuracy. Valid values can range from -3.4×10^{38} to 3.4×10^{38}.
	Double	Primitive 64-bit data type. Double is a floating point data type that accommodates decimal values, up to 14 or 15 significant digits of accuracy. Valid values can range from -1.7×10^{308} to 1.7×10^{308}.
Destination	*New image*	Shows the converted dataset in a new image window.
	Replace image	Replaces the current active dataset with the converted dataset.
Range of input values	*Use entire image range*	Converts all intensity values to the result image range when converting the image to a different type.
	Use user-defined range	Converts only the intensity values in the user-defined range when converting the image to a different type.
	Start input range	Specifies the intensity value at the beginning of the input range. The default value is the image minimum.
	End input range	Specifies the intensity value at the end of the input range.

Figure 222. Convert Image Type dialog box (continued)

Range of output values	*Starting range*	Specifies the intensity value at the beginning of the output range. The default value is the image minimum.
	Ending range	Specifies the intensity value at the end of the output range.
Process each slice independently (2.5D)	Converts each image slice independently as if it was a separate image. This options works for 2.5D images.	
Endianess	Data organization strategy. Refers to the way computer processors store data in memory.	
	Little endian	Stores the least significant byte (LSB) first.
	Big endian	Stores the most significant byte (MSB) first.
OK	Applies the parameters that you specified to convert the dataset.	
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not convert the dataset.	
Help	Displays online help for this dialog box.	

Figure 222. Convert Image Type dialog box (continued)

CONVERTING GRAYSCALE IMAGES TO RGB IMAGES

You can convert grayscale image datasets to RGB. RGB images have three channels (red, green, and blue) that contain image data.If you open two datasets in one image window, you can create a composite image that contains a mixture of the red, green, and blue channels.

To convert grayscale images to RGB images

1. Open an image.
2. Select Utilities >Conversion Tools> Grays -> RGB. The Concatenate -> RGB dialog box opens.
3. Select the image to which you want to apply the red channel in the Image (red) list. If you loaded two images into the image window, two file names should appear.
4. Do the same for the Image (green) list and the Image (blue) list.

5 Indicate whether you want to remap to current intensity values to the full standard 0–255 RGB values.

Note: Generally, each color is defined as one of the 256 intensities. If you remap the grayscale intensities and select Remap data, the system defines the intensities as one of the 256 values. If one or all of the input images have values that exceed 255 and you do *not* select Remap data, then data truncates to 255 since a color channel can only represent values 0–255.

6 Click OK. A status message appears. When filtering is complete, the new RGB image appears in a separate image window.

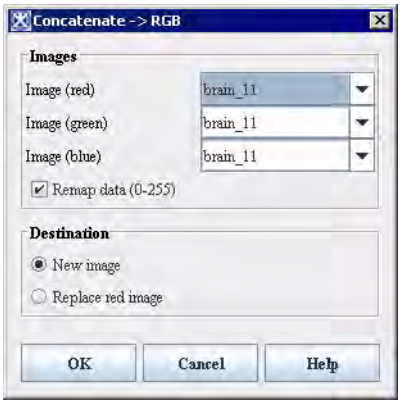


Image (red)	Identifies the image to be added to the red channel of the resulting image.
Image (green)	Identifies the image to be added to the green channel of the resulting image.
Image (blue)	Identifies the image to be added to the blue channel of the resulting image.
Remap data (0-255)	Indicates, when selected, that you want image intensities to be remapped to values 0-255, which is the standard for RGB images.
Destination	
New image	Sends the output to a new image frame.
Replace image	Replaces the existing image.
OK	Applies the parameters that you specified to create an RGB image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not create an RGB image.
Help	Displays online help for this dialog box.

Figure 223. Concatenate -> RGB dialog box

CONVERTING RGB DATASETS TO GRAYSCALE DATASETS

On the Utilities > Conversion Tools menu in the MIPAV window, the RGB conversion utility offers both a manual and an automatic method of converting RGB datasets to grayscale RGB images.

- **Manual conversion**—In the manual method of conversion, you select Utilities >Conversion Tools > RGB -> Gray to display the RGB -> Gray dialog box (Figure 224). The dialog box provides three weighting methods:
  - *Equal weights*—This method assigns equal weights to each of the three color channels. When you select this option, you can also select the **Only average RGB values greater than** check box and specify a threshold value. For example, if you specify a threshold value of 50, the program ignores any pixel in that channel that contains a value over 50.

Note: You can only specify a threshold when you choose to use the equal weights method of conversion.

  - *Computer graphics weights*—This method assigns the weights to each channel that are typically used to display computer graphics.
  - *User-specified weights*—In this method, you enter the specific weights for each color channel.
- **Automatic conversion**—If, instead, you select Utilities > >Conversion Tools > RGB -> Grays, the program automatically converts the RGB image to three grayscale images: one each for the red, blue, and green channels.

RGB datasets have four channels: red, green, blue, and alpha. When you convert RGB datasets to grayscale. RGB images, the intensities are combined to form a single grayscale value.

For example:

$$N = R \times RW + G \times GW + B \times BW$$

Where,

N = New grayscale pixel

R = Red channel

G = Green channel

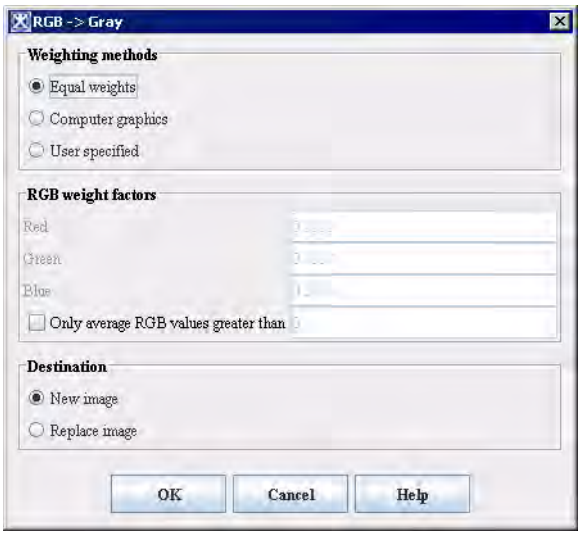
B = Blue channel

RW = Weight assigned to the red channel

GW = Weight assigned to the green channel

BW = Weight assigned to the blue channel

Equal weights	Assigns the same weight (0.3333) to each channel in the image. When you select this option, the Only average RGB values great than becomes available.
Computer graphics	Assigns the weighting factors typically used in computer graphics to each channel in the image: • Red, 0.299 • Green, 0.587 • Blue, 0.114



User specified	Specifies a weight that you determine for each channel. When you select this check box, you must type a specific weight for each channel in the Red, Green, and Blue boxes.
Red	Specifies the weight assigned to the red channel in the image. You can only specify a weight in this box if you selected the User specified option.
Green	Specifies the weight assigned to the green channel in the image. You can only specify a weight in this box if you selected the User specified option.
Blue	Specifies the weight assigned to the blue channel in the image. You can only specify a weight in this box if you selected the User specified option.
Only average RGB values greater than	Excludes any voxel in the image over the threshold value that you specify in this box. This check box is only available when you select the Equal Weights option.
New Image	Sends the output to a new image frame.

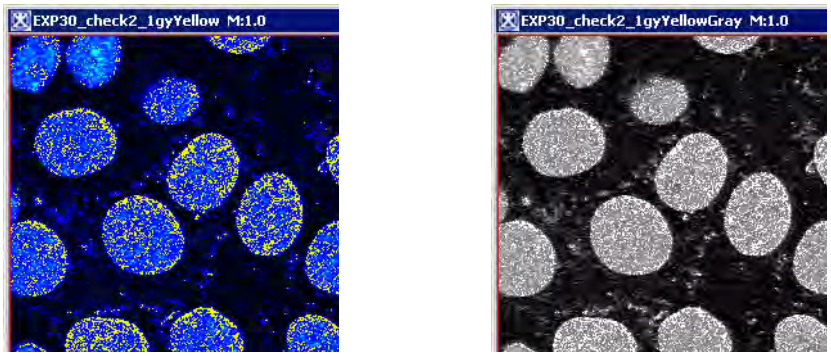
Figure 224. RGB -> Gray dialog box

Replace Image	Replaces the existing image.
OK	Applies the parameters that you specified to create a grayscale image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not create a grayscale image.
Help	Displays online help for this dialog box.

Figure 224. RGB -> Gray dialog box (continued)

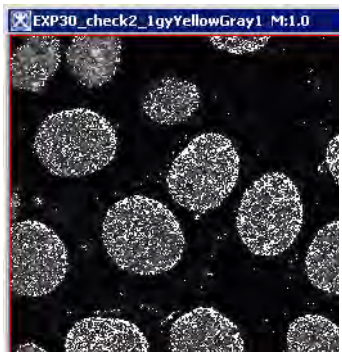
To manually convert RGB datasets to grayscale

1. Select Utilities > RGB > RGB -> Gray: The RGB -> Gray dialog box (Figure 224) opens.
2. Select one of the following weighting methods: equal weights, computer graphics, or user specified.
   - If you selected Equal Weights, decide whether to apply a threshold to the RGB channels. If you want to apply a threshold, select Only average RGB values greater than and enter the threshold value. Then go to the next step.
   - If you selected Computer graphics or User specified, go to the next step.
3. Click OK. A status message appears. In a few moments, the image is replaced by the new grayscale dataset.

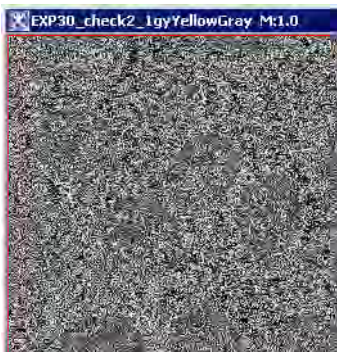


A B

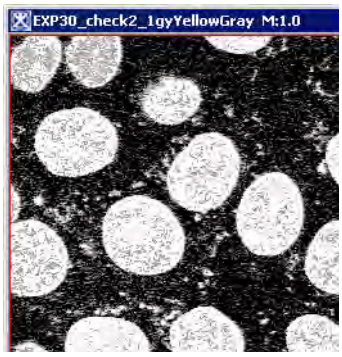
Figure 225. Manually converting RGB datasets to grayscale



C



D



E

A – the original image

B – the image converted to grayscale using Equal Weights

C – the image converted to grayscale using Computer Graphics

D – the image converted to grayscale using the User Specified RGB weight factors (0.33 for each channel)

E – the image converted to grayscale using combined options – Equal Weights and average values greater than 50

Figure 225. Manually converting RGB datasets to grayscale (continued)

To automatically convert RGB datasets to grayscale image

Select Utilities > RGB > RGB -> Grays. The program briefly displays a status message during the conversion and then generates three new grayscale datasets, one for each channel.

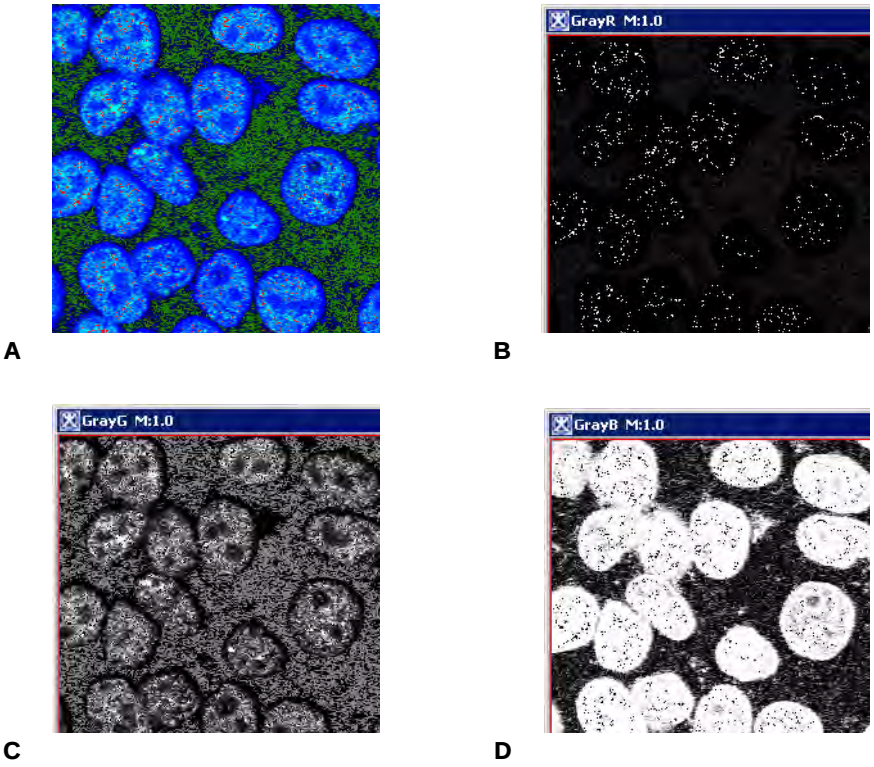


Figure 226. Example of three grayscale datasets generated automatically from an RGB dataset. Here, A is an original RGB image, B – gray red channel image, C – gray green channel image, and D –gray blue channel image.

Correcting image spacing

The Correct Image Spacing command on the Utilities menu corrects images in which slice thickness and slice spacing are unequal, which may distort images. To understand how this problem can occur, the following section presents some background information.

UNDERSTANDING CONTIGUOUS PLANES' EFFECT ON IMAGE SCANNING

Image scanning is usually done in contiguous planes. For example, if the first slice is centered at position 5.0 and the slices are 2 mm thick, the

second slice is centered at 7.0. In such a case, the slice thickness, 2, and the slice spacing, 2, are equal. There are, however, two scenarios when the slice spacing does not equal the slice thickness:

- **Slice spacing is less than the slice thickness**—In this case, although the images are, for example, 2 mm thick, they are spaced only 1 mm apart (Figure 227). This scenario arises when the ZIP x 2 feature is used during MRI scanning, which enables the acquisition of slices only 1 mm apart but uses signals from a 2-mm slab to increase the signal-to-noise ratio.
- **Slice spacing is greater than the slice thickness**—This scenario (Figure 227), which is more common than the first, occurs when the operator chooses to acquire images at intervals greater than the slice thickness (i.e., there is a gap between successive image slices) in order to cover a deeper field of view.

MIPAV assumes that successive images are contiguous. So, for example, if users chose the triplanar view to display an image that had slice spacing larger than slice thickness, the image would appear shortened in the out-of-plane direction. The Correct Image Spacing utility corrects both situations in which the slice thickness and spacing are not equal. Once the correction is applied, the slice thickness and slice spacing for the given image dataset are the same.

UNDERSTANDING HOW MIPAV SOLVES THE IMAGE SPACING PROBLEM

When the spacing between slices is *less* than the slice thickness, the Correct Image Spacing utility assigns the slice spacing to the slice thickness (refer to Figure 227 on page 407 for triplanar views before and after correction). When the slice spacing is *larger* than the slice thickness (refer to Figure 227 on page 407 for triplanar views before and after correction), the utility inserts blank slices between the existing images.

Since all slices within an image volume must have the same slice thickness, in many cases more than one slice must be inserted and the original images must be repeated so that a new value can be found for the slice thickness that fits evenly into the original slice spacing. Since there are an infinite number of combinations of slice spacing and thickness, not all could be handled. Table 4 displays the most common combinations and the

algorithms MIPAV uses for handling them.

T = Original slice thickness

S = Original space between slices

G = Gap = *S* - *T*

M = Number of original images

O = Original image set origin

N = New slice thickness

To use the Correct Image Spacing utility, DICOM images must first be saved in XML format. The following DICOM tags (Figure 227 on page 407) are used:

- (0018, 0050) Slice Thickness
- (0018, 0088) Spacing Between Slices

You can also find this information listed in the Essential Image Information section of the image header (Figure 227 on page 407) as Pixel resolution 2 (i.e., slice thickness) and Slice Spacing.

To view image attributes

1. Open an image.
2. Select Image > Attributes > View Header. The Header dialog box (Figure 227) opens.
3. Find the tags under Essential Image Information to find the values for Pixel resolution 2 and Slice Spacing, or find the values of the DICOM tags Slice Thickness and Spacing Between Slices.

Table 4. Solutions for correct image spacing

Case	New slice thickness (*N*)	Number of images in new set for each original image	Number of blanks inserted for each original image	Total images in set now	New image set origin $\left(O-\frac{T}{2}+\frac{N}{2}\right)$
$T = S$	T	1	0	M	O
$S < T$	S	1	0	M	O
$G > O$ and $\frac{G}{T} mod 1 = 0$	T	1	$1 \cdot \frac{G}{T}$	$\left(1+\frac{G}{T}\right) \cdot M$	$O-\frac{T}{2}+\frac{(N)}{2}$
$G > O$ and $\frac{T}{G} mod 1 = 0$	G	$1 \cdot \frac{T}{G}$	1	$\left(1+\frac{T}{G}\right) \cdot M$	$O-\frac{T}{2}+\frac{(G)}{2}$
$G > O$ and $\left(2 \cdot \frac{G}{T}\right) mod 1 = 0$	$\frac{T}{2}$	2	$2 \cdot \frac{G}{T}$	$\left(2+2 \cdot \frac{G}{T}\right) \cdot M$	$O-\frac{T}{2}+\frac{\left(\frac{N}{2}\right)}{2}$
$G > O$ and $\left(2 \cdot \frac{T}{G}\right) mod 1 = 0$	$\frac{G}{2}$	$2 \cdot \frac{T}{G}$	2	$\left(2+2 \cdot \frac{T}{G}\right) \cdot M$	$O-\frac{T}{2}+\frac{\left(\frac{G}{2}\right)}{2}$
$G > O$ and $\left(3 \cdot \frac{G}{T}\right) mod 1 = 0$	$\frac{T}{3}$	3	$3 \cdot \frac{G}{T}$	$\left(3+3 \cdot \frac{G}{T}\right) \cdot M$	$O-\frac{T}{2}+\frac{\left(\frac{N}{3}\right)}{2}$
$G > O$ and $\left(3 \cdot \frac{T}{G}\right) mod 1 = 0$	$\frac{G}{3}$	$3 \cdot \frac{T}{G}$	3	$\left(3+3 \cdot \frac{T}{G}\right) \cdot M$	$O-\frac{T}{2}+\frac{\left(\frac{G}{3}\right)}{2}$
else	don't handle, give message				

Legend:

T = Original slice thickness

S = Original space between slices

G = Gap = S - T

M = Number of original images

O = Original image set origin

N = New slice thickness

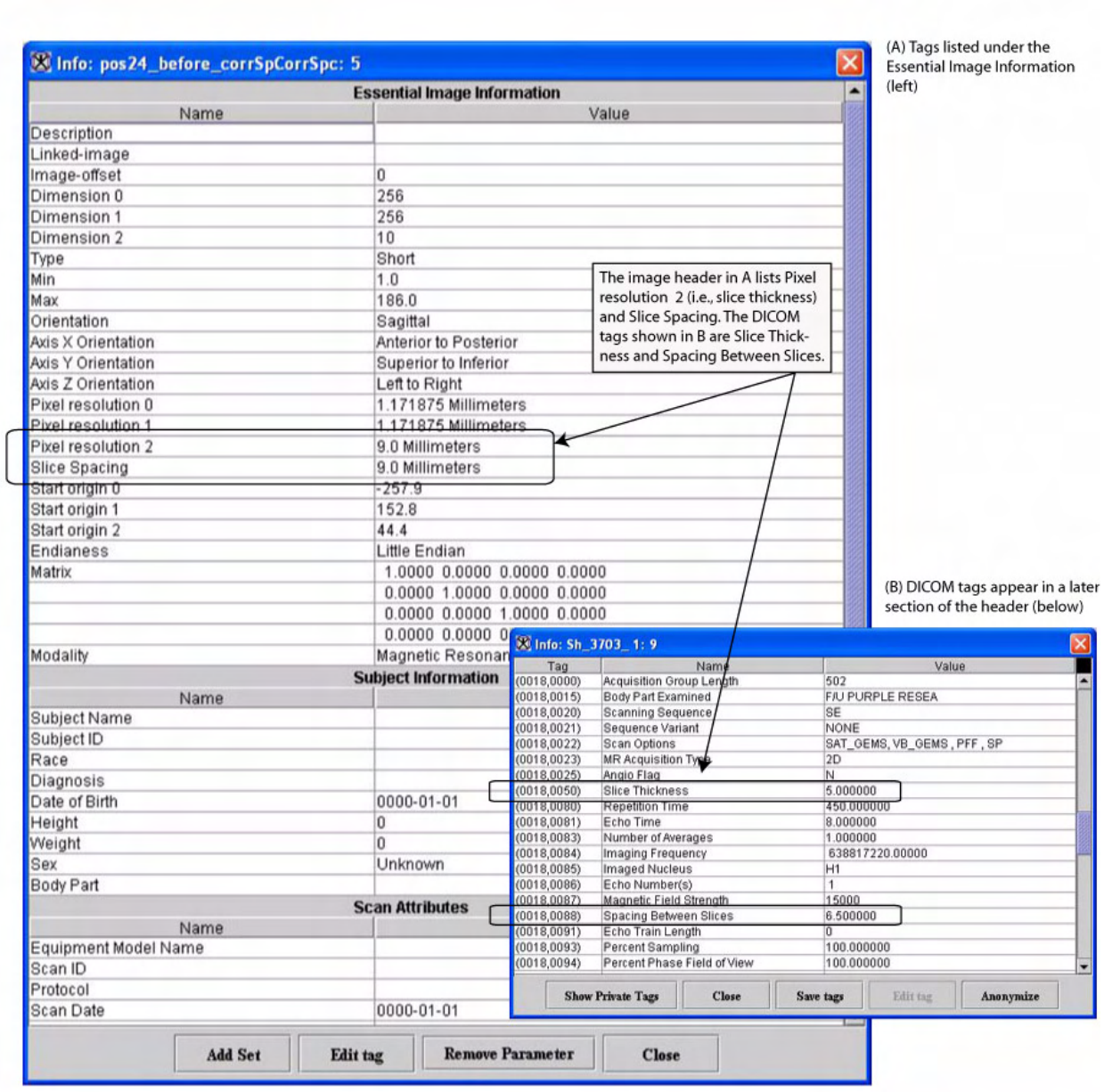


Figure 227. Views of the Header dialog box showing the tags listed under (A) Essential Image Information and (B) the DICOM tags in a later section of the header

To save DICOM images as XML files

The Correct Image Spacing utility works only on XML files.

1. Open the DICOM image.
2. Select File > Save Image as in the MIPAV window. The Open dialog box appears.
3. Type the name for the file including the XML extension in File Name.
4. The Select DICOM tags to convert to XML dialog box opens.
5. In the left dialog box window, select tags which you would like to convert to XML. Use the CTRL+right mouse button combination of keys to select multiple tags. Then, use the arrows to move selected tags to the right window. See Figure 228 for more information.
6. Press Save to save the file.

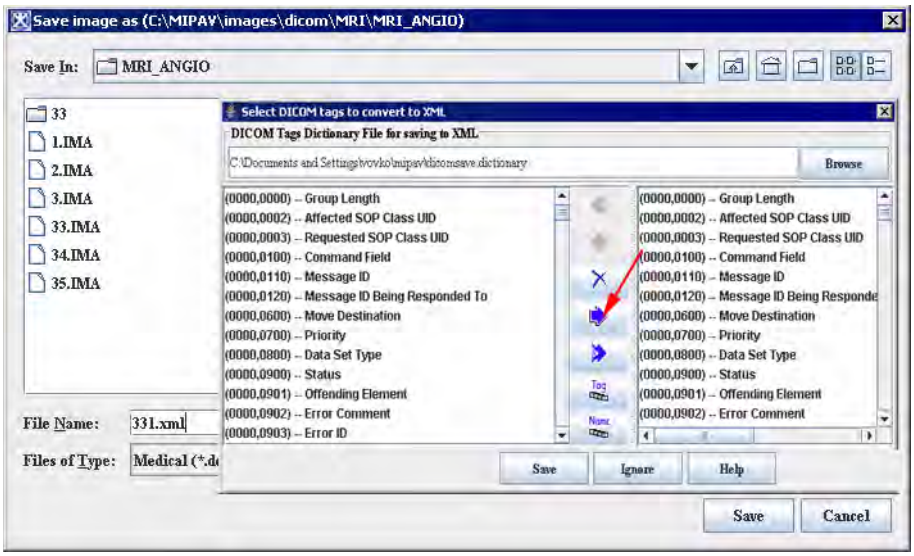


Figure 228. Saving a DICOM image as an XML file

To save other images as XML files

The Correct Image Spacing utility works only on XML files.

1. Open the image that has spacing problems if you have not already done so.
2. Select File > Save Image as in the MIPAV window. The Open dialog box appears.
3. Type the name for the file including the XML extension in File Name.
4. Select Medical, which includes XML files, in Files of Type.
5. Click OK. The Save Range of Slices dialog box appears. Complete the dialog box and press OK. See Figure 229.
6. The program saves the image as an XML file.

General Options	
Save image slices to separate files	If checked, allows to save the image slices as separate files. The slices will be saved as files with the file name contains the name of the original image followed by the slice number specified by a user, e.g. `patientX001`. Here `patientX` is the name of the original image and `001` is the number of the slice. Refer to "Understanding contiguous planes' effect on image scanning" on page 403.
First File Starting Number **File Name Number of Digits**	Set the start counter number and how many digits will appear in the counter number.
Choose Range of Slices to Save	
First Slice	Specify the number of the first slice.
Last Slice	Specify the number of the last slice.
Choose Range of Time Periods to Save	
First Time period	Specify the first time period.

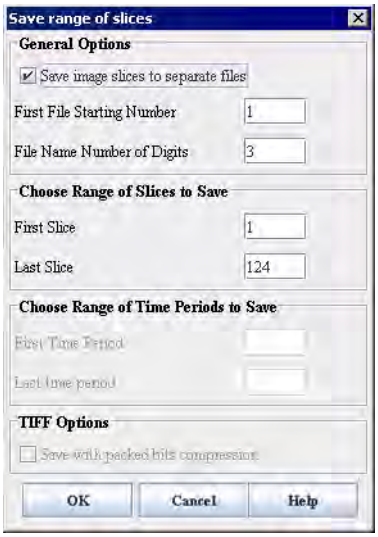


Figure 229. The Save Range of Slices dialog box options

Last Time Period	Specify the last time period.
TIFF options	
Save with packed bit compression	Packed bit compression uses a single control byte to indicate how the next byte or series of bytes will be used. The high bit in the control byte indicates if the following byte or bytes should be a used as a series or should be used as individual bytes. The remaining 7 bits indicate the number of bytes that are indicated in the control byte.
OK	Applies the changes you made in this dialog box, saves the image as a range of slices, and closes the dialog box.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not save the image as a range of slices.
Help	Displays online help for this dialog box.

Figure 229. The Save Range of Slices dialog box options (continued)

To correct image spacing

1 Open the image that contains spacing problems.

Tip: To determine whether images contain spacing problems, remember to view them using the triplanar view or to view the header file.

2 Save the image as an XML file.

3 Select Utility > Correct Image Spacing.

If the image file does have spacing problems, then the program runs the utility.

If the image spacing is correct, the program displays a message indicating that the spacing is correct.

Cropping images

You can use the Crop command on the Utilities menu to trim an image so that only the selected portion of the image remains.

To crop an image using a VOI

1. Open an image.
2. Draw one or more VOI contours on the image on the area that you want to remain in the image. When the utility is run, the area inside the contours remains and the areas outside the contour are discarded from the new dataset.

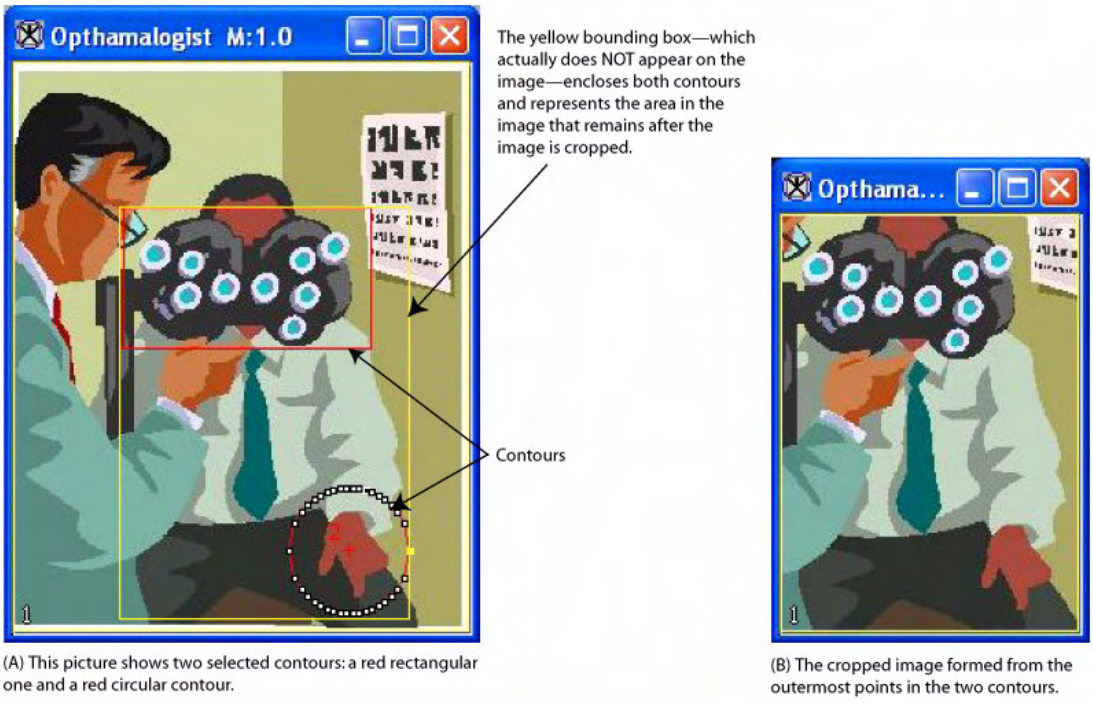
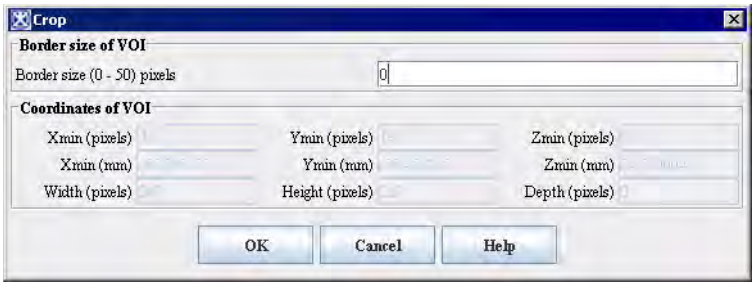


Figure 230. Contouring the area that should remain in the cropped image

3. Select the VOI or one or more of the contours.
4. Select Utilities > Crop. The Crop dialog box (Figure 231) appears.
5. Type the number of pixels that you want to use for the border size in Border size box. Specify a number from 0 to 50.

6 Select either the New image or the Replace image check box to indicate whether the program should display the cropped image in a new image window or replace the original image with the cropped image.

7 Click OK. After a moment, the new image appears.



Border size of VOI: **Border size (0 - 50)**	Indicates the width of a strip of voxels that surround (border) the contours. When you crop an image, the area inside the contours and the border remain. All other voxels are trimmed from the image.
Coordinates of VOI	Displays the coordinates for the X, Y, and Z axes of the VOI.
New image	Shows the cropped image in a new image window.
Replace image	Replaces the current active image with the cropped image.
OK	Applies the parameters that you specified to crop the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not crop the image.
Help	Displays online help for this dialog box.

Figure 231. The Crop dialog box options

To crop an image using parameters

1. Open an image.
2. Call Utilities>Crop>Using parameters.
3. The Crop Boundary Pixels dialog box appears, see Figure .
4. Select either the New image or the Replace image check box to indicate whether the program should display the cropped image in a new image window or replace the original image with the cropped image.
5. Complete the dialog box.
6. Click OK. After a moment, the new image appears.

Pixels around image	Specify the number of pixels which should be cropped. For 3D images, also specify the number of slices.
Select destination	**New Image** – shows the cropped image in a new image window. **Replace Image** – replaces the current active image with the cropped image.
OK	Applies the parameters that you specified to crop the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not crop the image.
Help	Displays online help for this dialog box.

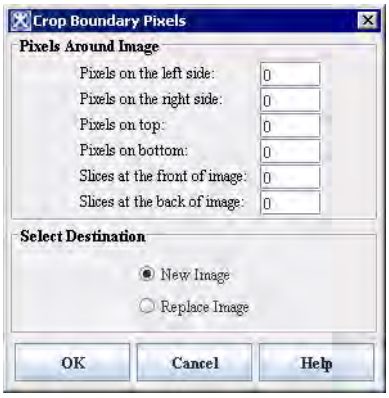


Figure 232. The Crop Boundary Pixels dialog box options

Masking (filling) images

Masks allow you to remove portions of images and display only those portions as separate image files. For example, you may only be interested in a section of an image and only want to display and work with that section.

To create a mask, you first, need to create one or more VOIs on the image. Depending on the type of mask you want to create, the VOIs should do either of the following:

- Enclose the image areas you want to preserve
- Enclose the image areas you do *not* want to preserve

If the VOIs indicate the areas of the image that should be deleted from the image, you need to create an *interior mask* and specify the number of pixels the program should use to hide the image inside the VOIs, or interior (Figure 233-B).

To preserve the image inside the VOIs, however, you need to create an *exterior mask*. An exterior mask fills the image outside of the VOIs with the number of pixels you specify. This filling hides the portions of the image outside the VOIs, or exterior (Figure 233-C).

Figure 233. An original image (A), interior mask (B) and exterior mask (C)

To create an interior mask

1. Open an image.
2. Create one or more VOIs that enclose the portions of the image that interest you.
3. Select Utilities > Fill. The Fill dialog box (Figure 234) opens.
4. Type the number of pixels to fill the interior of the VOIs.
5. Select Interior fill.
6. Select either New Image or Replace Image depending on which you prefer.
7. Click OK. The program either displays a new image or replaces the current image with an image that hides the portions of the image that are inside the VOIs (Figure -B).

To create an exterior mask

1. Open an image.
2. Create one or more VOIs that enclose the portions of the image that interest you.
3. Select Utilities > Fill. The Mask dialog box (Figure 234) opens.
4. Type the number of pixels to fill the interior of the VOIs.
5. Select Exterior fill.
6. Select either New Image or Replace Image depending on which you prefer.
7. Click OK. The program either displays a new image or replaces the current image with an image that hides the exterior of the image outside the VOIs (Figure -C).

Parameters	Specifies the value in pixels to fill the VOI.
Interior fill	Applies the value to the interior of the VOI.
Exterior fill	Applies the value to the exterior of the VOI.
New image	Shows the cropped image in a new image window.
Replace image	Replaces the current active image with the cropped image.
OK	Applies the parameters that you specified to mask the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not mask the image.
Help	Displays online help for this dialog box.

Figure 234. The Fill Image dialog box

Flipping images

MIPAV allows you to flip images either horizontally, or vertically, or invert the order of slices in the image dataset. The last option is available via the Utilities>Flip Image> In Depth menu (refer to page 417 for more information).

To flip an image,

1. Call Utilities > Flip > Horizontal, Vertical of In Depth.
2. Then, complete the dialog box that appears, and press OK.
3. After a few moments, the flopped image replaces the original image in the same image window. For dialog box options, refer to Figure 235.

Options	**Flip all VOIs** – flips an image along with all VOIs.
Flip Axis	Vertical (X Axis) – flips the image vertically; Horizontal (Y Axis) – flips the image horizontally; Depth (Z Axis) – flips the image about the Z axis.
OK	Applies the parameters that you specified to flip the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not flip the image.
Help	Displays online help for this dialog box.

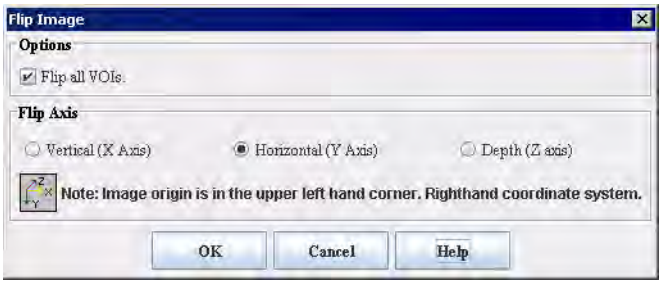


Figure 235. The Flip Image dialog box options

A B C

Figure 236. An original image (A), image flipped horizontally (B), and then vertically (C)

To invert the order of images in datasets

1. Open an image that contains slices.
2. Select Utilities > Flip> Flip in Depth.

   A status message appears and indicates that the software is reordering the slices in the dataset. In a moment or two the MIPAV window refreshes, and the image window in which the original dataset appeared displays the reordered slices.

Image Calculator

This algorithm adds, subtracts, multiplies, and divides, etc. the pixel values of one image by the pixel values of another image. In addition, two images can be ANDed, ORed or XORed together. Also, more advanced operator expressions can be entered in the dialog text field.

Background

Image Calculator performs arithmetic and logical operations between two images selected from popup menus.

The commands in the main Image Calculator dialog box take the pixel values of Image A, and then add, subtract, multiply, etc. them to the pixel values of Image B. For 2D and 3D images the specified operation is performed on all image slices. Refer to Figure 249.

The advanced dialog options (refer to page 429) allow performing advanced math operations on both images and also performing math operations on the selected image using the specified constant, e.g. *Image A*C*, where *C* is a constant.

CLIP MODE

When clip mode is selected and the result value is greater than the maximum value of Image A's data type, the value is clamped at the maximum value of Image A's data type. When clip mode is selected and the result value is less than the minimum value of Image A's data type, then the value is clamped at the minimum value of Image A's data type. See Figure 249.

PROMOTION MODE

When the Promote Destination Image Type mode is selected and the result value is not within the legal range of Image A data type, then the result image type is promoted from the default of the Image A data type to a new

data type with a data type range capable of expressing the minimum and maximum values.

Promotion sequence:

- Boolean is promoted to byte, byte is promoted to unsigned byte, unsigned byte is promoted to short, short is promoted to unsigned short, unsigned short is promoted to integer, integer is promoted to unsigned integer, unsigned integer is promoted to long, long is promoted to float, and float is promoted to double. Double is not promoted.
- Color with 3 bytes is promoted to color with 3 unsigned shorts, and color with 3 unsigned shorts is promoted to color with 3 floats. Color with 3 floats is not promoted.
- Complex is promoted to double complex.
- Double complex is not promoted.

IMAGE TYPES

You can apply Image Calculator to all 2D and 3D color and grayscale images. Image A and Image B must have the same number of dimensions and the length of every dimension in Image A must equal the length of the same dimension in Image B. Also, both Image A and Image B must be color images, or both Image A and Image B must be black and white images. The Image Calculator will not accept one black and white Image And one color image. There are no other restrictions on data type.

Image calculator options

ADD

Adds the pixel values of Image A to the pixel values of Image B. Basically, this operation adds the colors of the overlay to the background causing the two images ether overflow, or saturate. However, if the added colors excess the color limits, the color will be capped (or clamped) and the result will not necessarily be as you expect.

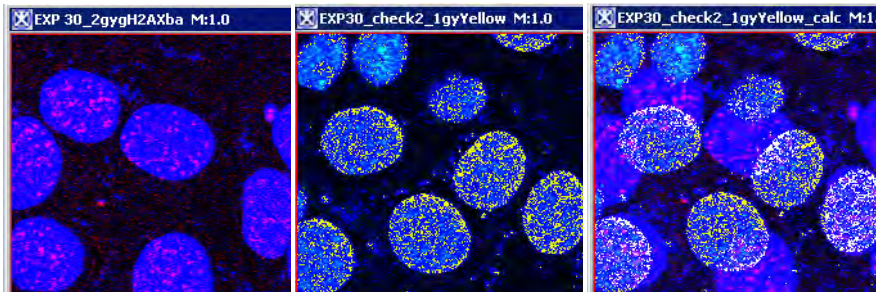


Image A sample point (255.0,0.0,255.0) | Image B (0.0,12.0,255.0) | Result= Image A + Image B (255.0,12.0,255.0)

Figure 237. Adding Image A and Image B

AND

Does AND of the Image A and the specified Image B. For each pixel in Image A, the Image A pixel value is set to zero, if either the Image A pixel value equals zero, or corresponding Image B pixel value equals zero. Otherwise, the Image A pixel value is left unchanged.

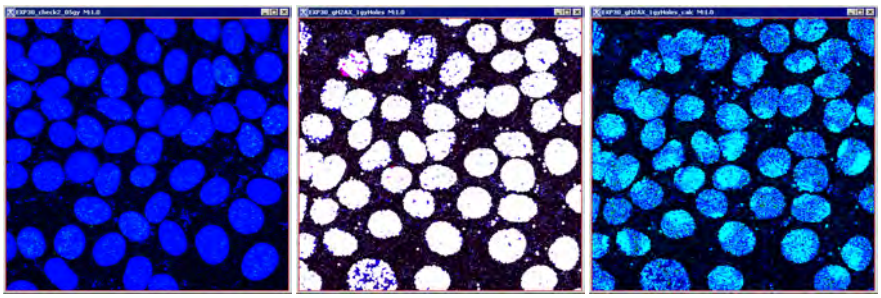


Image A | Image B | Result=(Image A AND Image B)

Figure 238. ANDing images

AVERAGE

Average of two images is calculated as (Image A + Image B)/2.

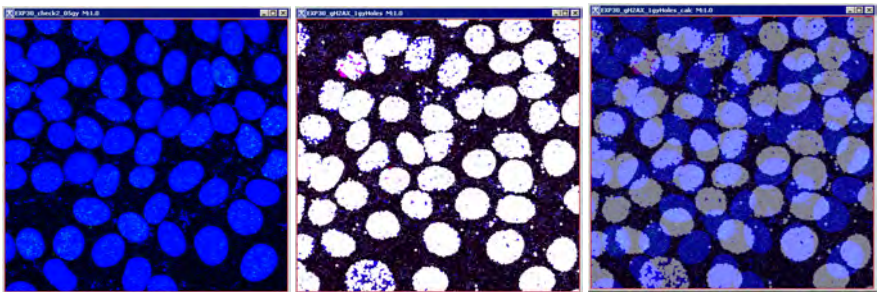


Image A | Image B | (Image A+Image B)/2

Figure 239. Averaging images

MAXIMUM

RGB values for pixels in the Image A and the corresponding RGB values for the Image B are compared, and then replaced with the greater RGB values. As shown in Figure 240 below, for a chosen point, it took MAX R=12.0 from Image B, MAX G=30.0 from Image A, and MAX B=243.0 from Image A.

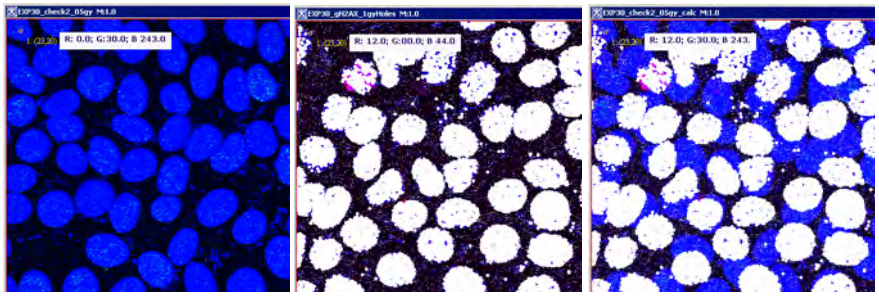


Image A, for the selected point RGB is (0.0, **30.0**, **243.0**) | Image B, RGB (**12.0**, 0.0, 44.0) | Result=MAX (Image A, Image B), RGB (12.0, 30.0, 243.0)

Figure 240. Maximum (Image A; Image B)

MINIMUM

RGB values for pixels in the Image A and the corresponding RGB values for the Image B are compared, and then replaced with the minimum RGB values. As shown in Figure 241 below, for a chosen point, it took MIN R=0.0

from Image A, MIN G=00.0 from Image B, and MIN B=44.0 from Image B.

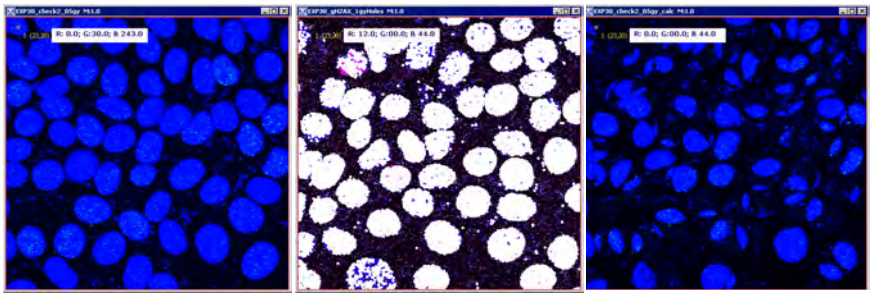


Image A, for the selected point RGB is (**0.0**, 30.0, 243.0)

Image B, RGB (12.0, **0.0**, **44.0**)

Result=MIN (Image A; Image B), RGB (0.0, 0.0, 44.0)

Figure 241. Minimum(Image A; Image B)

MULTIPLY

Multiplies the Image A pixel values by the Image B pixel values. In clip mode, for RGB images with byte values, results greater than 255 are set to 255. This method works very well if one image (either A, or B) is basically black or gray, or just has a light background, see Figure 242. If both images are color images, then you may get strange results. This technique is also perfect for overlaying line drawings, diagrams or images on an image with very light white or colored background. See also “clip mode” on page 418.

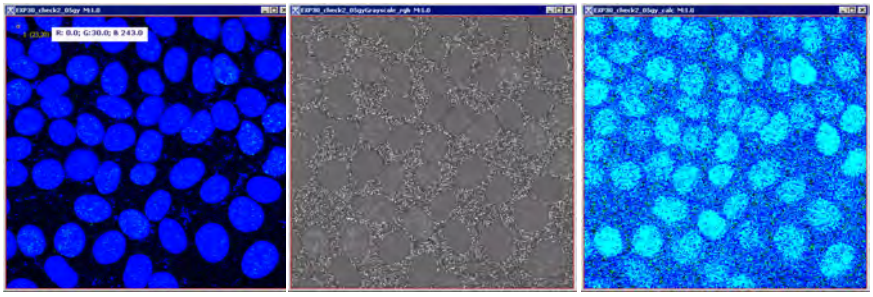


Image A

Image B

Image A*Image B

Figure 242. Multiply(Image A; Image B)

DIFFERENCE

The difference operation is a sequence of two operations. First, a subtraction operation is performed. Then, the absolute value of the result of the subtraction operation is taken. The variation between the colors black and white difference will produce a maximum result of white. However, any colors which are the same will produce black. You can use this function to see where images are similar and where they differ.

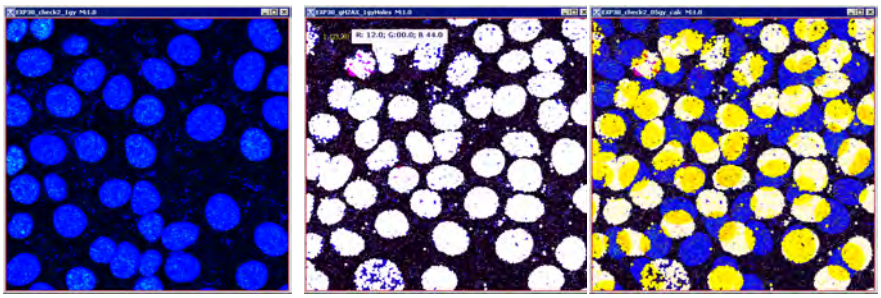


Image A Image B |Image A-Image B|

Figure 243. Difference (Image A; Image B)

DIVIDE

Divides the pixel values of Image A by the specified Image B. A positive number divided by zero could yield either the maximum positive value, or positive infinity. A negative number divided by zero could yield either the maximum negative value or negative infinity. Zero divided by zero could yield either zero or not a number.

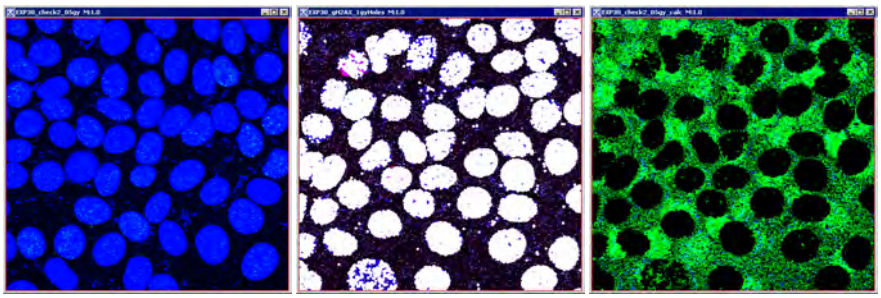


Image A Image B Image A/Image B

Figure 244. Dividing images

OR

If the pixel value from a chosen pixel in Image A equals zero, then the result pixel value is set equal to the corresponding Image B pixel value. Otherwise, the result pixel value is the same as for the Image A (i.e. stays unchanged).

- Result=Image B, if Image A=0;
- otherwise, Result=Image A.

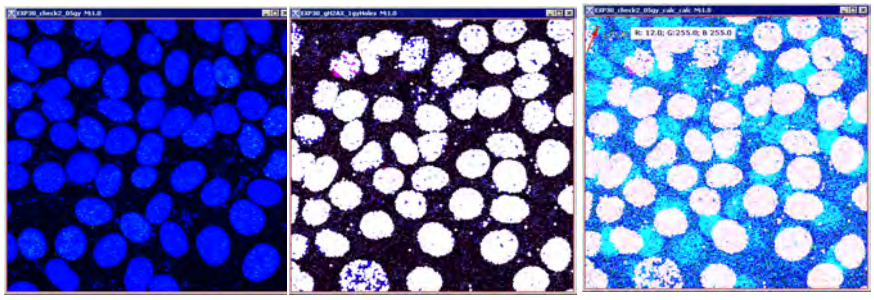


Image A Image B (Image A OR Image B)

Figure 245. OR(Image A; Image B)

XOR

It overlays two images together, but then clears the area that is overlapped back to transparency. If both Image A and Image B pixel values are nonzero, then the result image is set to zero. If both Image A and Image B pixel values

are zero, then the result image remains zero. If only one of Image A and Image B is nonzero, then the result retains or assumes the nonzero value.

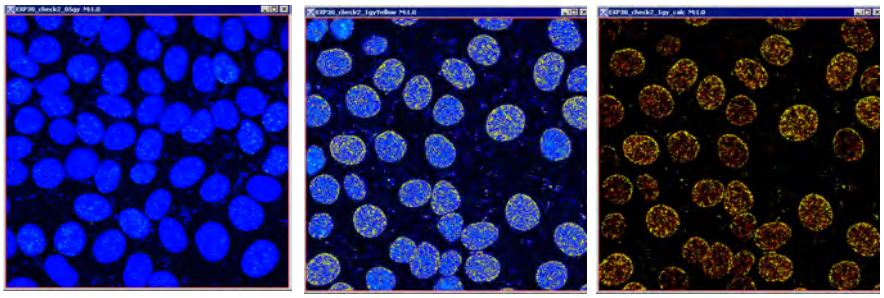


Image A Image B (Image A XOR Image B)

Figure 246. XOR(Image A; Image B)

SUBTRACT

Subtracts the pixel values of Image B from the corresponding pixel values of Image A.

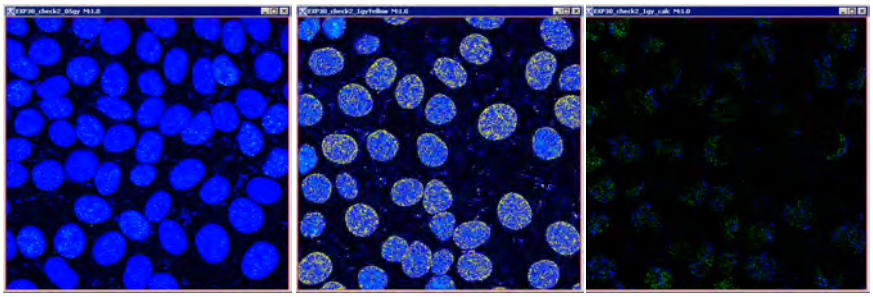


Image A Image B Image A-Image B

Figure 247. Subtract(Image A; Image B)

Advanced math options

ABS

Generates the absolute value of the active image or selection.

EXP

Applies the function *f(p) = exp(p)* to each pixel (p) in the image or selection. For RGB images, this function is applied to all three color channels.

LN

Applies the function *f(p) = ln(p)* to each pixel (p) of the image or selection. For RGB images, this function is applied to all three color channels.

LOG

Applies the function *f(p) = log(p)* to each pixel (p) in the image or selection. For RGB images, this function is applied to all three color channels.

POW

The function *pow (x,y)* produces a value of x raised to the power of y, e.g., *pow(2,3)* gives 8. For RGB images, this function is applied to all three color channels. In clip mode, for RGB images with byte values, results greater than 255 are set to 255. In promote destination image mode, the image will be promoted to ARGB_USHORT and capable of storing color values of up to 65535.

SIN, COS, TAN

Apply the functions *sin(p)*, *cos(p)*, and *tan(p)* to each pixel (p) of the image or selection. For RGB images, the chosen function is applied to all three color channels.

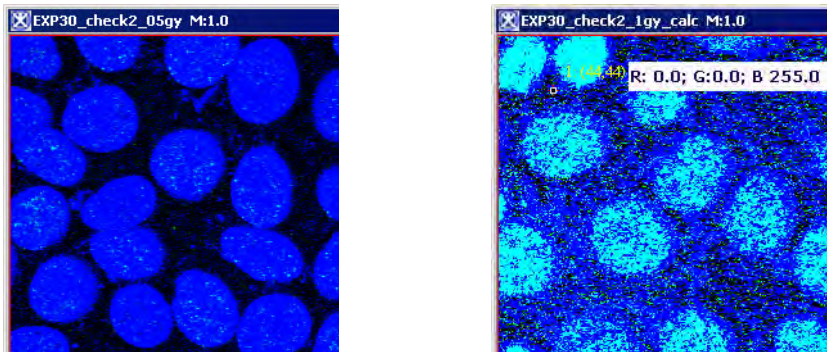


Image A f(p)=pow(Image A;3)

Figure 248. Image A after applying f(p)=pow(Image A;3). The function was applied for all three color channels. The result values greater than 255, as for the B channel, were set to 255

Applying the Image Calculator to images

To run this algorithm, complete the following steps:

1. Open at least two images. The images must have the same dimensions.
2. Select Utilities >Image Calculator. The dialog box opens. See Figure 249.
3. Use the Operator list box to select the math operator (Add, AND, Average, etc.).
4. Use the Image B list box to select Image B.
5. Check the Clip option if you want to clamp result data to the bounds of the input image type. Check the Promote option to promote image type so that the range of the result fits into the new image type. Refer to “clip mode” on page 418 and “promotion mode” on page 418.
6. Click OK. The algorithm begins to run.

7 Depending on whether you selected New Image or Replace Image A, the result appears in a new window or replaces the image to which the algorithm was applied.

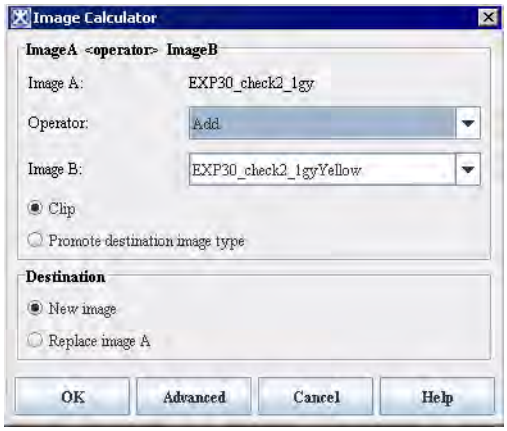


Image A	Image A.
Operator	Select the math operator from the list.
Image B	Select Image B from the list.
Clip	Select this option if you want the result image to be clamped at the maximum (minimum) value of Image A data type. See also "clip mode" on page 418.
Promote destination image type	When this mode is selected and the result value is out of the legal range of Image A data type, then the result image type is promoted to a new data type with a data type range capable of expressing the minimum and maximum values. See also "promotion mode" on page 418.
Destination	
New image	The result image will open in a new image frame.
Replace image	The result image will replace Image A.
OK	Applies the algorithm according to the specifications in this dialog box.
Advanced	Calls the Enter Advanced Operator dialog box.
Cancel	Disregards any changes that you made in this dialog box and closes it.
Help	Displays online help for this dialog box.

Figure 249. The Image Calculator dialog box options

ADVANCED IMAGE CALCULATOR OPTIONS

To use advanced options provided by the Image Calculator dialog box, complete the following steps:

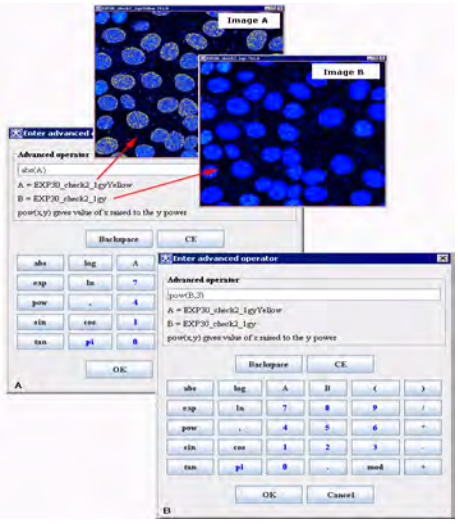
1. Open at least two images. The images must have the same dimensions.
2. Select Utilities >Image Calculator. The dialog box opens.
3. Use the Image B list box to select Image B.
4. Check the Clip option if you want to clamp result data to the bounds of the input image type. Check the Promote option to promote image type so that the range of the result fits into the new image type.
5. Use the Advanced button to call the advanced options. The Enter Advanced Operator dialog box appears.
6. Use the dialog box options to perform any of the standard operations for which you would normally use a handheld calculator. Advanced operator performs on the images basic arithmetic, such as addition and subtraction, as well as functions found on a scientific calculator, such as logarithms and exponent.

Note: that in this dialog box you can combine images and constants in one math operation.

7. Click OK. The algorithm begins to run.
8. Depending on whether you selected New image or Replace Image A, the result appears in a new window or replaces the Image A to which the algorithm was applied.

Enter Advanced Operator dialog box

A= [file name]	Image A.
B=[file name]	Image B.
All available math functions can be entered in the Advanced operator text box manually or using the corresponding buttons.	
Numbers also can be entered in the Advanced Operator text box manually or using the calculator buttons.	



Backspace

Uses the same function as the Backspace button in the handlend calculator.

CE

Uses the same function as the CE button in the handlend calculator.

OK

Applies the algorithm according to the specifications in this dialog box.

Cancel	Disregards any changes that you made in this dialog box and closes it.
Help	Displays online help for this dialog box.

Figure 250. The Enter Advanced Operator dialog box options

REFERENCES

The parsing of the advanced operator expression is largely based on the file *Func.java* by Leen Ammeraal. The Func.java file appears at *ftp://ftp.expa.fnt.hvu.nl/pub/ammeraal* and *http://home.wxs.nl/~ammeraal*

It is also contained in Chapter 8 of *Computer Graphics for Java Programmers* by Leen Ammeraal, Copyright 1998 by John Wiley & Sons Ltd.

Image Math

Algorithm that adds, subtracts, multiplies, or divides an image by some user specified value. In addition, the square root, absolute value, or log of an image can be calculated. If the new image exceeds the range that can be stored in an image of that type, the data is either clipped and stored in the original image or a new image of a type (int, float...) that can store the range of new data is generated.

See also: "Image Calculator", Sections "clip mode" and "promotion mode" on page 418.

IMAGE TYPES

You can apply Image Calculator to all 2D and 3D grayscale images. And here is the difference between Image Math and Image Calculator (refer to "Image Calculator" on page 418). The last one you can ally to all types of images 2D, 3D, 4D color and grayscale.

Applying the Image Math to images

To run this algorithm, complete the following steps:

1. Open an image of interest.
2. Select Utilities >Image Math. The dialog box opens. See Figure 251.
3. Use the Operator list box to select the math operator (Absolute value, Add, Average, etc.).
4. Use the Value text box to enter a numerical value.
5. Select the Clip option if you want to clamp result data to the bounds of the input image type. Select the Promote option to promote image type so that the range of the result fits into the new image type. Select the Convert to Float option to convert the result into float image type.
6. Click OK. The algorithm begins to run.

7 Depending on whether you selected New Image or Replace Image, the result appears in a new window or replaces the image to which the algorithm was applied. See also Figure 251.

Value	Enter the numerical value here. Note that the text box become available after you select the math operator.
Operator	Select the math operator from the list.
Clip	Select this option if you want the result image to be clamped at the maximum (minimum) value of the original image data type. See also "clip mode" on page 418.
Promote image type	When this mode is selected and the result value is out of the legal range of the original image data type, then the result image type is promoted to a new data type with a data type range capable of expressing the minimum and maximum values. See also "promotion mode" on page 418.
Convert to float	When this mode is selected and the result value is out of the legal range of the original image data type, then the result image type is converted to float data type.
Destination	
New image	The result image will open in a new image frame.
Replace image	The result image will replace the original image.
Process	
Whole image	The algorithm applies to the selected VOI(s) region.
VOI region	The algorithm applies to the whole image.

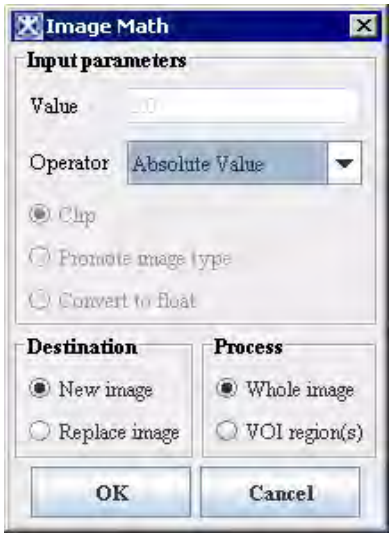
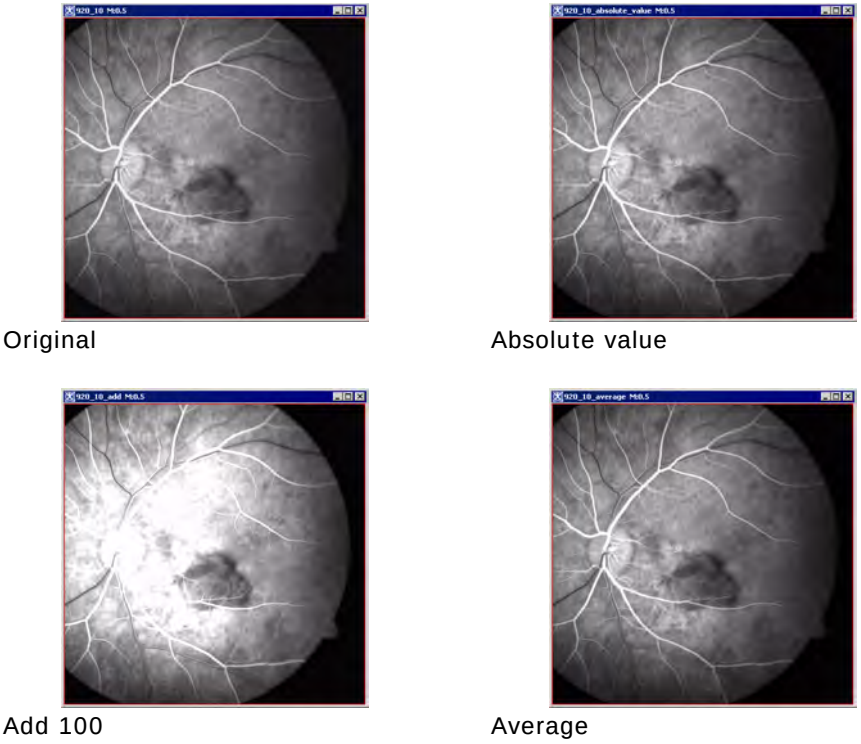


Figure 251. The Image Math dialog box options

OK	Applies the algorithm according to the specifications in this dialog box.
Advanced	Calls the Enter Advanced Operator dialog box.
Cancel	Disregards any changes that you made in this dialog box and closes it.
Help	Displays online help for this dialog box.

Figure 251. The Image Math dialog box options (continued)

EXAMPLES OF USING IMAGE MATH



Original | Absolute value

Add 100 | Average

Figure 252. Applying Image Math to images

Constant

Divide by 100

Log

Multiply by 5

Square

Square root

Subtract 5

Sum

Figure 252. Applying Image Math to images (continued)

Inverting the image

The Utilities>Invert command inverts the colors of the image, creating a photo-negative effect. There are no options for this effect. Simply select New Image to send the inverted image to a new image frame or Replace Image to overwrite the file with your changes, or click Cancel to discard the changes and leave the image as-is.

Figure 253. The Invert Image dialog box

Matching images

The Match Images command on the Utilities menu assists in any comparison of two images. To use this utility, you need to first open two images: image A, which has the desired characteristics, and image B, whose characteristics need to match those of Image A. The Match Images dialog box presents the following four ways in which you can match the images:

- **Match image orientation**—Rotates Image B so that its orientation is the same as the orientation of image A.
- **Match resolutions**—Subsamples the image for each dimension with lower resolution (i.e., larger pixel size) so that both images have the same resolution. To ensure that the fields of view remain the same, the program adds extra pixels to the image.
- **Match origins**—Adds margins to one of the images for each dimension if the origins (i.e., the starting location) of the two images are not the same. The program also adds pixels to the left, top, or front of the image.
- **Match image dimensions**—Adds pixels to the right, bottom, or back of either image so that they have the same dimensions.

You can select one or more of these choices in the dialog box. Before actually performing any selected comparison, MIPAV first checks to see whether the images do not already match in that regard. If they do, the given match is not performed.

To match image orientation

1. Open two images.
2. Select Utilities > Match images. The Match Images dialog box (Figure 254) opens.
3. Select one of the open images as image A, and select the other image as image B.
4. Select Match image orientations (based on imaging orientation).
5. Select any or all of the other check boxes to also, if desired, match image resolutions, origins, or dimensions.
6. Click OK. If the orientations of the images differ, the program changes the orientation of Image B to match that of image A.

To match image resolutions

1. Open two images.
2. Select Utilities > Match images. The Match Images dialog box (Figure 254) opens.
3. Select one of the open images as image A, and select the other image as image B.
4. Select Match image orientations (based on imaging orientation).
5. Select any or all of the other check boxes to also, if desired, match image resolutions, origins, or dimensions.
6. Click OK. If the resolutions of the images differ, the program changes the resolution of Image B to match that of image A.

To match image origins

1. Open two images.
2. Select Utilities > Match images. The Match Images dialog box (Figure 254) opens.

3 Select one of the open images as image A, and select the other image as image B.

4 Select Match image origins (by adding margins where necessary).

5 Select any or all of the other check boxes to also, if desired, match image orientations, resolutions, or dimensions.

6 Click OK. If the origins of the images differ, the program changes the origin of Image B to match that of image A.

To match image dimensions

1 Open two images.

2 Select Utilities > Match images. The Match Images dialog box (Figure 254) opens.

3 Select one of the open images as image A, and select the other image as image B.

4 Select Match image dimensions.

5 Select any or all of the other check boxes to also, if desired, match image orientations, resolutions, or origins.

6 Click OK. If the dimensions of the images differ, the program changes the dimension of Image B to match that of image A.

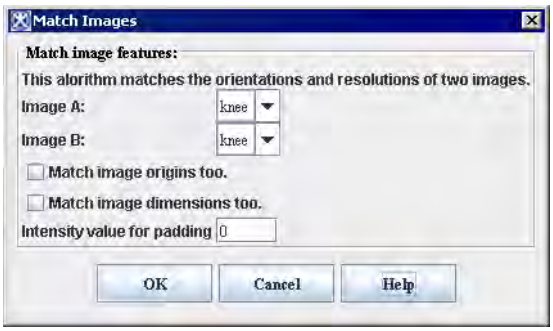


Image A	Specifies the image that contains the orientation, resolution, origins, or dimensions with which Image B needs to match.
Image B	Specifies the image on which to perform the image matching.
Match image orientations (based on imaging orientation)	Applies the image orientations (based on image orientation) used in Image A to Image B.

Figure 254. Match Images dialog box

Match image resolutions, axis by axis (subsampling image with lower resolution)	Matches the image resolutions in Image A to Image B. Note that this subsamples Image A with a lower resolution if necessary.
Match image origins (by adding margins where necessary)	Matches the image origins used in Image A to Image B. Note that, if necessary, this adds margins to Image B.
Match image dimensions	Applies the image dimensions used in Image A to Image B.
OK	Applies the parameters that you specified to add margins to this image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not perform image matching.
Help	Displays online help for this dialog box.

Figure 254. Match Images dialog box (continued)

Maximum Intensity Projection

Maximum Intensity Projection (MIP) is a volume rendering technique for 3D images that projects in the visualization plane the voxels with maximum intensity that fall in the way of parallel rays traced from the viewpoint to the plane of projection. At each pixel the highest data value encountered along the corresponding viewing ray is determined.

MIP exploits the fact, that within MRI data sets the intensity values of vascular structures are higher than the intensity values of the surrounding tissue. By depicting the maximum intensity value seen through each pixel, the structure of the vessels contained in the image can be captured.

The method provides a very good understanding of the structures defined by high signal intensities. It also helps to avoid the problem with occluding structures, which can block visualization of thin inner parts.

Background

A MIP algorithm accepts a single grayscale 3D image and generates three 2D images representing the maximum intensities in *x*, *y*, and *z* directions.

Let **I** be an input grayscale 3D image of size (m*n* l). Let **X**, **Y,** and **Z** be the output 2D images representing the maximum intensities in *x*, *y*, and *z* directions.

X is a 2D image of size ($y^* z$) formed by viewing along the x-axis and selecting the highest intensities in the $y–z$ plane. **Y** image is of size (x^*z) formed by viewing along the y-axis and selecting highest intensities in the $x–z$ plane. Similarly, **Z** image is formed by viewing along the Z axis and selecting highest intensities in the $x–y$ plane and is of size ($x * y$).

Note: The MIP algorithm allows to set the minimum and maximum thresholds on the image before computation which aids in enhancing MIP visualization in certain cases.

IMAGE TYPES

This algorithm works with 3D grayscale images (all image types except complex). By default, the result images are of type float.

SPECIAL NOTES

The origin of the result images is at the top left corner and the original resolutions of the 3D image in all directions are preserved.

Applying the Maximum Intensity Projection

To run the method,

1. Open an image of interest.
2. Select Utilities > Maximum intensity projection (MIP).
3. The Maximum Intensity Projection dialog box appears.
4. Complete the dialog box. You might choose to fill out two input fields – Threshold Minimum and Threshold Maximum; or just use the default values. These fields are initially populated with the minimum and maximum intensities of the image.
5. Click OK.

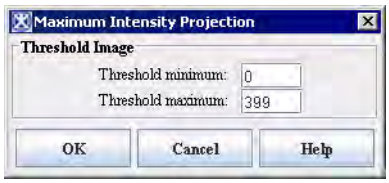


Figure 255. The Maximum Intensity Projection dialog box. The input fields are initially populated with the maximum and minimum intensities of the image

The algorithm begins to run, and a pop-up window appears with the status. The following message appears: *Computing Maximum Intensity Projection*. When the algorithm has finished to run, the pop-up window closes and the three 2D images appear in three different windows. See Figure 256.

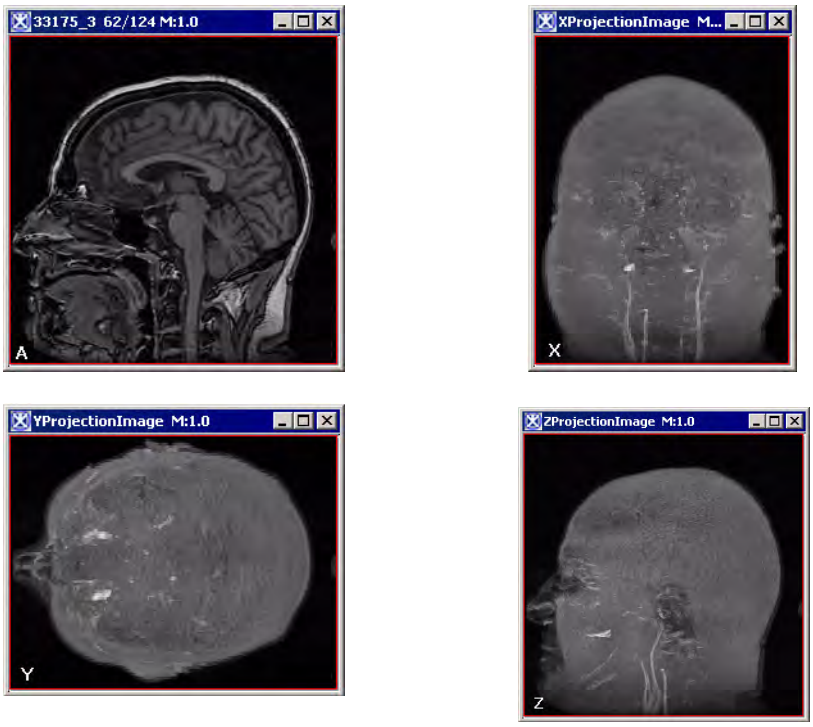


Figure 256. The original image (A) and three 2D result images; x–projection (X), y–projection (Y), and z–projection (Z)

Adding noise to images

Adding noise to images allows you to test the robustness and performance of an algorithm in the presence of known amounts of noise. When you select Utilities > Noise, the program clamps either Gaussian or Uniform noise to the lowest or highest value in the source image type.

For example, for a byte image, if the intensity of the source pixel is 120 and noise is 15, then intensity + noise = 135. This value (135) would be clamped to the maximum pixel value for a byte image (127).

This class relies heavily on the Java Random class and is used to generate a stream of pseudorandom numbers. The class uses a 48-bit seed, which is modified using a linear congruency formula (refer to Donald Knuth, *The Art of Computer Programming*, Volume 2, Section 3.2.1.).

To add noise to images

1. Open an image on which you want to test the effectiveness of an algorithm.
2. Select Utilities > Noise in the MIPAV window. The program displays the Additive Noise dialog box (Figure 257).
3. Type the level of noise that you want to add to the image in the Noise level box. You can specify a value from 10 to 32,768.

Noise level (0-32768)	Specifies the level of noise to add to the image. The default value is 10.
Noise Type	
Gaussian	Adds Gaussian noise to the image.
Uniform	Adds Uniform noise to the image.
Destination	
New image	Shows the cropped image in a new image window.
Replace image	Replaces the current active image with the cropped image.

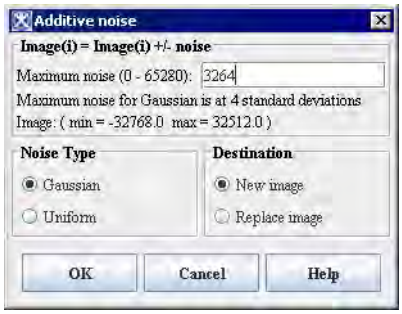


Figure 257. Additive Noise dialog box

OK	Applies the parameters that you specified for adding noise to this image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not add noise to this image.
Help	Displays online help for this dialog box.

Figure 257. Additive Noise dialog box (continued)

4 Type the level of noise that you want to add to the image in the Noise level box. You can specify a value from 10 to 32,768.

5 Select either of the following:

- *Gaussian*—To add Gaussian noise to the image
- *Uniform*—To add Uniform noise to the image

6 Select either of the following:

- *New image*—To generate the resulting image in a new image window
- *Replace image*—To replace the current image with the resulting image

7 Click OK. The program adds the Gaussian or Uniform noise to the image and displays either a new image or replaces the current image with the one to which noise was added.

8 Now, select the algorithm in the Algorithms menu to test its effectiveness on the image.

Example

In the following example (Figure 258), the original image appears at the top of the figure. The next row shows the image on the left that results from adding Uniform noise of 1000. To its right is the image after running the Median algorithm. The image on the left on the last row results from adding Gaussian noise of 1000 to the original image. Running the Median algorithm on that image produces the image on its right. In this example, the Median algorithm performs better on an image containing Gaussian noise.

A

A is an original image

B is the image after applying Uniform noise (1000)

C is the image B after applying the Median filter

D is the image after adding Gaussian noise (1000)

F is the image D after running the Median filter on it

B

C

E

F

Figure 258. Examples of adding a noise to an image, and then using it to test an algorithm's effectiveness in removing the noise

Pad

The Pad command on the Utilities menu allows to pad images with certain values specified by the user.

To use the Pad utility

1. Open an image of interest.
2. Call Utilities>Pad.
3. The Pad Image dialog box appears. Enter the number of pixels to be padded on the left side, right side, top and bottom. If the image is a 3D image, you can also add a number slices to the front or back of the image.
4. Specify the intensity value for padded pixels.
5. Click OK. Depending on the selected option – New Image or Replace Image – the padded image appears either in a new image frame or replaces the original image.

Pixels Around Image	
Pixels on the left side	Specify the number of pixels to add to the left side of the image.
Pixels on the right side	Specify the number of pixels to add to the right side of the image.
Pixels on top	Specify the number of pixels to add to the top of the image.
Pixels on bottom	Specify the number of pixels to add to the bottom of the image.
Slides at the front of image	Specify the number of slices to add to the front of the image.
Slides at the back of image	Specify the number of slices to add to the back of the image.
Pad value	Specify the intensity value for the added pixels.

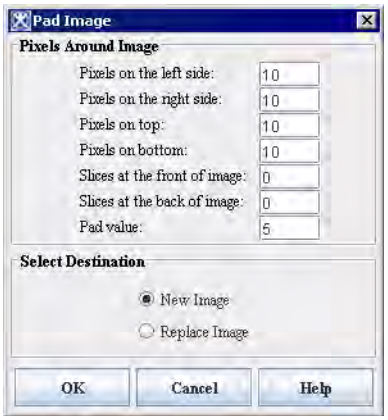


Figure 259. The Pad Image dialog box

	Destination
New image	Shows the padded image in a new image window.
Replace image	Replaces the current active image with the padded image.
OK	Applies the padding values that you specified to the image.
Cancel	Disregards any changes you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 259. The Pad Image dialog box (continued)

Figure 260. The original image (on your left) and the image padded to (10;10;10;10). The intensity value for padded pixels is set to 200

Quantify Mask

There are two algorithms Quantify Mask(s) and Quantify Using Mask that calculate Center of Mass, area (in resolutions), and number of pixels for a selected mask(s). The algorithms work with Boolean, byte, unsigned byte, and short masks.

Identify Image Mask file		
Choose	Press to select an image mask from your hard drive.	
OK	Applies the Quantify masks(s) or Quantify Using Mask algorithms to the image(s).	

Figure 261. The Quantify dialog box

Cancel	Disregards any changes you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 261. The Quantify dialog box

To apply the Quantify Mask(s) algorithm:

1. Open an image of interest.
2. Create a mask as described in Chapter 8, "Generating masks".
3. Save the mask as Boolean, byte, unsigned byte, or short.
4. Alternatively, you can open the mask file from the disk using the Quantify dialog box options.

Note: the algorithm doesn't work for paint masks.

5. Call Utilities>Quantify> Quantify Mask(s).
6. The algorithm begins to run and the data appear in the Output window. See Figure 262.
7. Later, you can save the data using the File>Save Images option provided by the Output window.

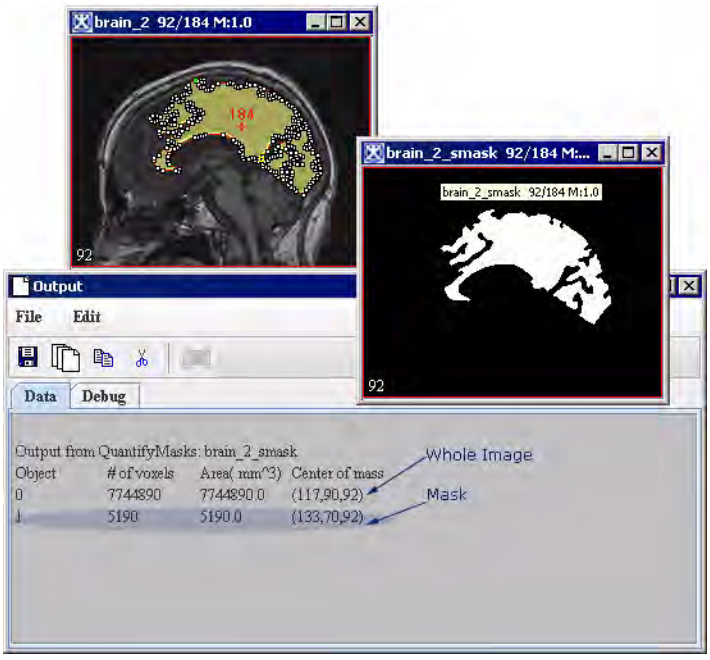


Figure 262. The Quantify Mask(s) algorithm

To apply the Quantify Using Mask algorithm:

1. Open an image of interest.
2. Create the image mask as described in Chapter 8, "Generating masks".
3. Alternatively, you can open the mask file from the disk.
4. Call Utilities>Quantify> Quantify Using Mask.
5. The algorithm begins to run and the data appear in the Output window. See Figure 263.
6. Later, you can save the data using the File>Save Images option provided by the Output window.

Note: the algorithm works with Boolean, byte, unsigned byte, and short masks, but it doesn't work with paint masks.

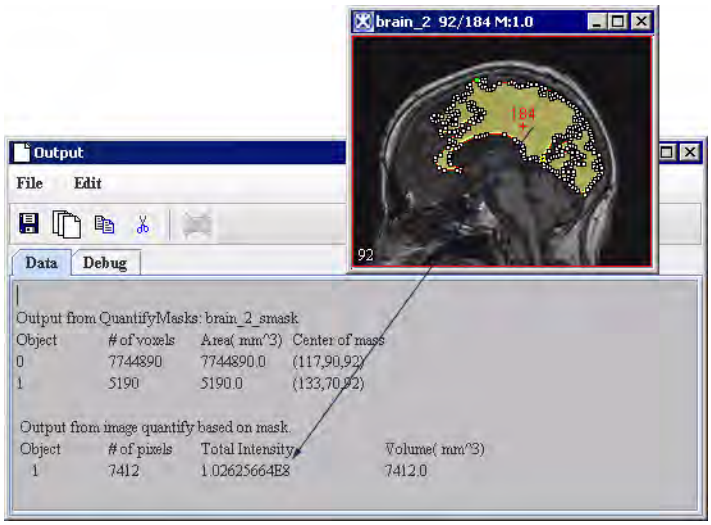


Figure 263. The Quantify Using Mask algorithm

Replacing pixel/voxel value in images

You can replace the values of pixels or voxels in images by using the Replace pixel/voxel values command on the Utilities menu. Suppose, for example, that you have a set of images that contain *not a number* (NaN) values. To be able to use MIPAV algorithms on those images, you first need to replace those not a number values. The Replace pixel/voxel value command provides an easy way to replace those values or any pixel or voxel values.

To replace pixel or voxel value in images

1. Open the image whose pixels or voxels you want to change.
2. Select Utilities > Replace pixel/voxel values.

   The Replace Pixel/Voxel Value dialog box (Figure 264) opens.

User-defined value	Specifies the value that you want to replace in the image.
Presets	*NaN*—Not a number. ∞—Positive infinity. -∞—Negative infinity.
Replace with	Accept the default value or type another value.
New image	Shows in a new image window the image in which the value was replaced.
Replace image	Replaces the current image with the image in which the value was replaced.
OK	Applies the parameters that you specified to subsample the image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not subsample the image.
Help	Displays online help for this dialog box.

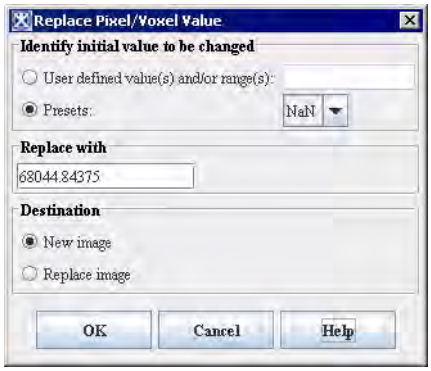


Figure 264. Replace Pixel/Voxel Value dialog box

3 Do one of the following:

a Select User defined value and type the value that you want to replace in the text box

b Select Presets and then select one of the following in the list box:

- *NaN*—Not a number
- ∞—Positive infinity
- -∞—Negative infinity

4 Do one of the following:

- Accept the default value in Replace with.
- Type another value in the text box.

5 Select one of the following:

- *New image*—To create a new image in its own image window using the replaced value

- *Replace image*—To overwrite the original image in the original image window with an image using the replaced value

6 Click OK. The image with the replaced value appears in either a new window or in the original image window.

Rotating images

You can rotate images about the *x*, *y*, and *z* axes. For example, suppose that you opened the following image:

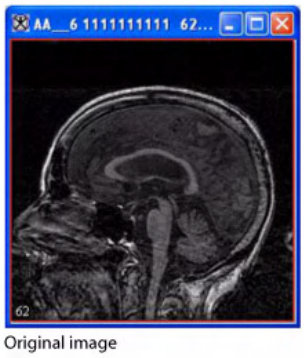


Figure 265. Original image to be rotated

To rotate images

1. Select Utilities > Rotate in the MIPAV window.
2. Select one of the following:
   - *X Axis +90:* To rotate the image about the *x* axis by +90 degrees.
   - *X Axis -90:* To rotate the image about the *x* axis by -90 degrees.
   - *Y Axis +90:* To rotate the image about the *y* axis by +90 degrees.
   - *Y Axis -90:* To rotate the image about the *y* axis by -90 degrees.
   - *Z Axis +90:* To rotate the image about the *z* axis by +90 degrees.
   - *Z Axis -90:* To rotate the image about the z axis by -90 degrees.

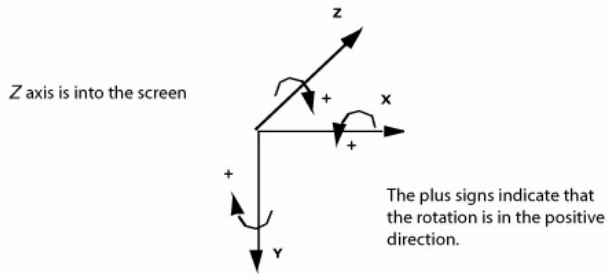


Figure 266. Rotation

A status message appears. When rotation is complete, the status window closes, and MIPAV replaces the original image in the image window with the rotated image.

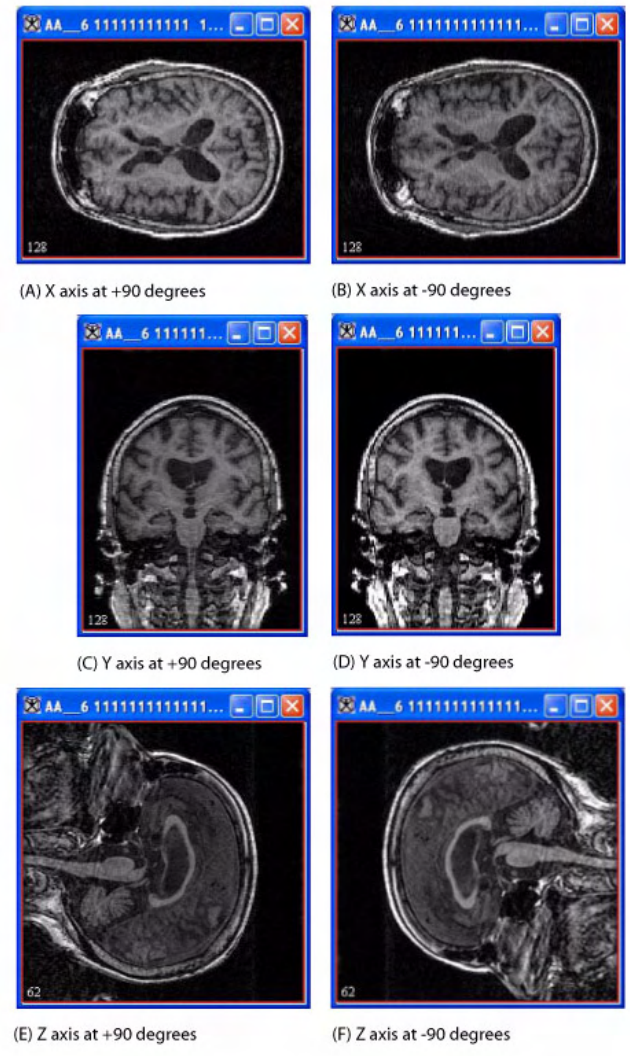


Figure 267. Examples of rotating images

This figure shows the image in Figure 265 at the six different types of x, y, and z rotation.

Slice tools

Concatenating images

The Concatenate command on the Utilities menu provides you with a way to append, or add, two datasets together.

To concatenate image datasets

1. Open the two datasets that you want to join.
2. Select the dataset to which you want to append the other dataset.
3. Select Utilities > Concatenate. The Concatenate Images dialog box (Figure 268) opens.
4. Note that the dataset you selected appears in read-only form in the box labeled Image A.
5. Select Image B, which is the name of the dataset that you want to add to the end of Image A.
6. Select the dimensionality that you want for the resulting dataset by selecting either 3D or 4D.

Note: If both datasets contain the same number of slices, you can select either 3D or 4D. If the datasets contain a different number of slices, you can only select 3D.

7. Click OK. The program adds the Image B dataset to the end of the Image A dataset and displays the resulting dataset in a new image window.

Image A	Specifies the name of the dataset to which to append Image B. This dataset is the one you selected before using the Concatenate command.
Image B	Specifies the name of the dataset that you want to append to the Image A dataset.
3D	Indicates that the dataset that results from appending Image B to Image A is three dimensional.
4D	Indicates that the dataset that results from appending Image B to Image A is four dimensional.
OK	Applies the changes you made in this dialog box and closes the dialog box.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not append Image B to Image A.
Help	Displays online help for this dialog box.

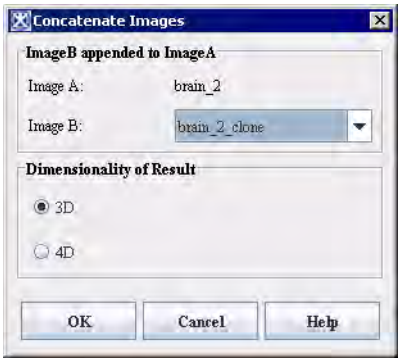


Figure 268. Concatenate Images dialog box

To verify that the datasets are joined

1. Select the new dataset that resulted from concatenating the Image A and Image B datasets.
2. Notice the following on the MIPAV window:
   - If you selected 3D as the dimensionality of the resulting dataset in the Concatenate Images dialog box, the image slice slider (Figure 269 upper part) lists twice as many slices as either the Image A and Image B datasets.
   - If you selected 4D as the dimensionality of the resulting dataset, a time slice slider (Figure 269 lover part) appears beneath the image slice slider and the image slice slider lists the same number of slices as the Image A and Image B datasets.

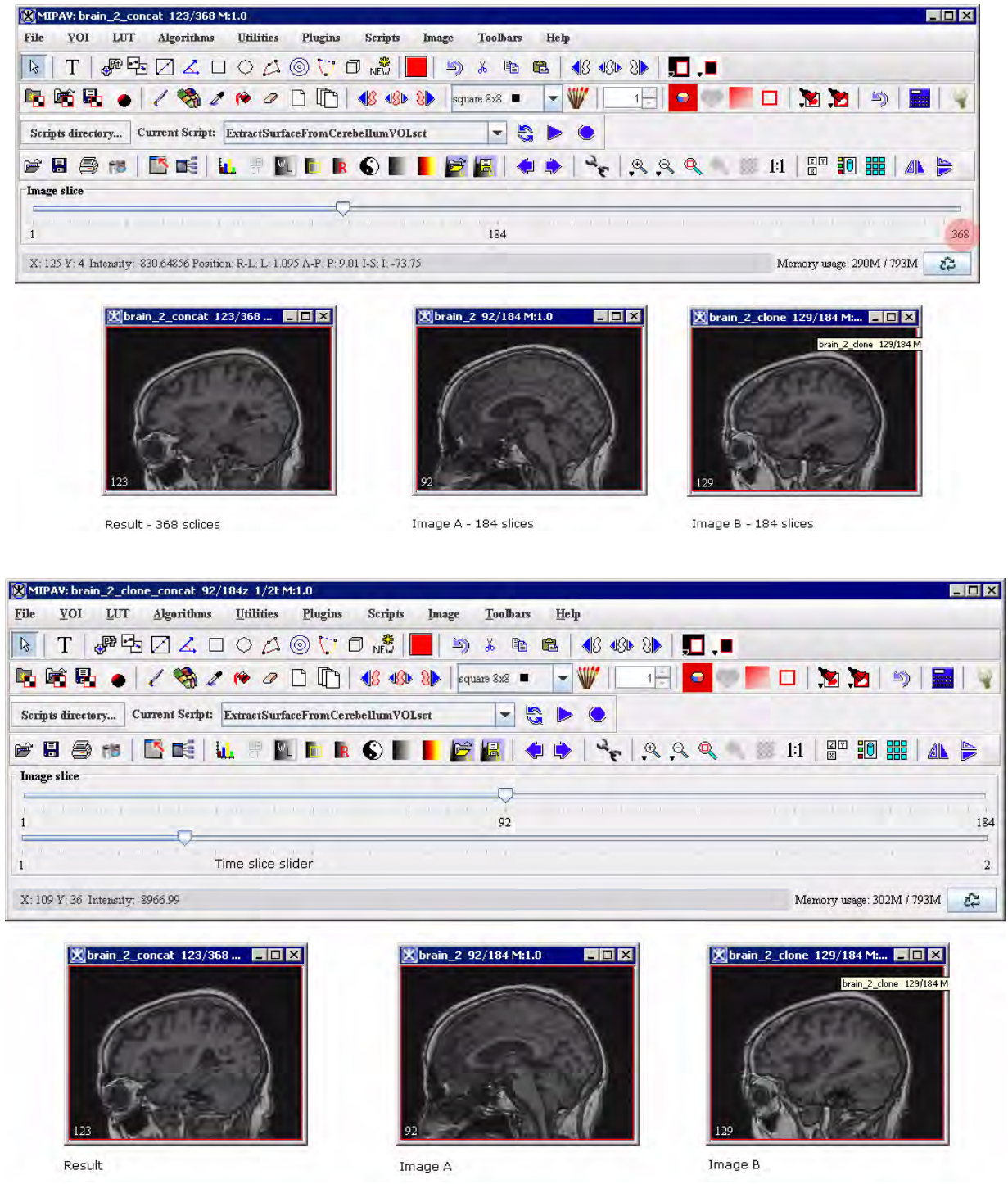


Figure 269. The MIPAV window after concatenating datasets to generate 3D (upper) or 4D (lover) datasets

Extracting slices/volumes

The Extract Slices/Volume utility makes copies of the slices or volumes you select and displays them in separate image windows. Unlike the Remove Slices utility, the original image dataset is untouched.

There are several ways to select slices or volumes. You can select all slices; only specific slices; only the even-numbered slices; only the odd-numbered slices; or one or more ranges of slices.

To extract slices or volumes from image datasets

1. Select Utilities > Slice Tools>Extract Slices/Volumes. The Extract Slices/Volumes dialog box opens.
2. Use the image slider in the MIPAV window to locate slices that you want to extract.
3. Decide whether to remove:

   - *All of the slices*—Click Select all. Check marks appear in all of the image slice check boxes.
   - *One or more slices*—Select the specific check boxes for the image slices. Check marks appear in only the check boxes you selected.
   - *One or more ranges of slices*—Select Specify range of slices, and then type the slice numbers or ranges of slice numbers in Enter slice numbers and/or slice ranges box.
   - *All even-numbered slices*—Click Check even. Check marks appear in only those check boxes for even-numbered slices, such as 2, 4, 6, and so on.
   - *All odd-numbered slices*—Click Check odd. Check marks appear in only those check boxes for odd-numbered slices, such as 1, 3, 5, and so on.

Tip: Use the image slider on the MIPAV window to look at specific slices to decide which slices to remove.

4. Click Extract. A status message appears. Then the MIPAV window refreshes and the slices you selected appear in new image windows.

Check the slices to extract	Indicates the slices that you want to extract from the dataset. You can scroll through the list to select one or more slices.
Select all	Selects all of the slices in the dataset to extract.
Clear	Clears all of the slices that are currently selected.
Check even	Selects all of the even-numbered slices to extract.
Check odd	Selects all of the odd-numbered slices to extract.
Specify range of slices	Indicates that you want to extract one or more specific slices or a range of slices from the dataset. If you select this check box, you must specify the slices or ranges of slices you want to extract in the Slice number and/or range of slices box below.
Enter slice numbers and/or slice ranges	Indicates the slices and range of slices that you want to extract. This box only becomes available after you select Specify range of slices.
Extract	Makes copies of the slices/volumes you selected and displays them in separate image windows.
Cancel	Disregards any changes that you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

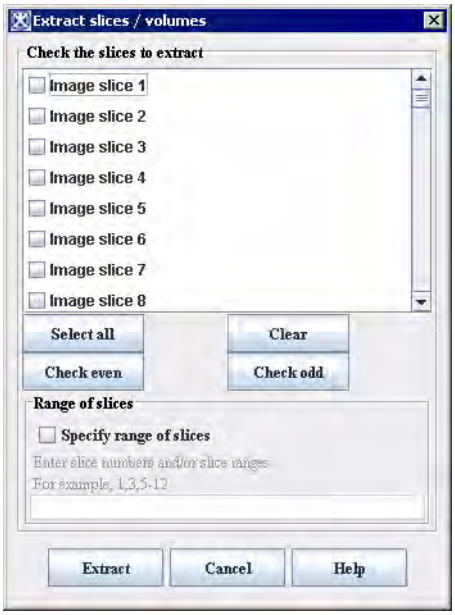


Figure 270. Extract Slices/Volumes dialog box

Insert Missing Slices

The Insert Missing Slices utility insert slices into the image dataset. There are several ways insert a slice into the image dataset. You can select Average, or Blank, or Original.

- If Average is selected, the inserted slice is set equal to the mean of the two surrounding slices, unless it is a new first of last slice. A new first or last slice preserves the usual slice spacing.
- If Blank is selected, the slice with all pixel zero is inserted.
- If the Original option is used, a 2D image of the same dimensions is inserted.

IMAGE TYPES

The algorithm works with 3D and 4D, grayscale, black and white, and color images. It preserves the image type when inserts slices, e.g. grayscale into grayscale images, color into color.

APPLYING INSERT MISSING SLICES

To insert a slice to an image dataset

1. Select Utilities > Slice tools>Insert Missing Slices. The Insert Missing Slices dialog box opens.
2. The dialog box appears displaying a note at the top of window that indicates how many slices are missing.
3. Now, you have to choose the method for slice insertion: Average, Blank, or Original.
4. Select the destination. Choose New image if you want the image with inserted slices appear in a new image frame; choose Replace image to replace the original image.
5. Click OK to proceed.

Insert before slice (1-n) or enter n+1 for new last slice	Specifies the position of the new slice.
Average	Inserts a slice that is the average the adjacent slices.
Copy previous adjacent	Insert a slice that is a copy of the preceding slice.
Copy next adjacent	Inserts a slice that is a copy of the following slice.
Blank	Inserts a blank slice.
Original	Inserts an image from the original dataset.
OK	Applies the parameters that you specified to insert the slice in the image dataset.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not insert the slice into the image dataset.
Help	Displays online help for this dialog box.

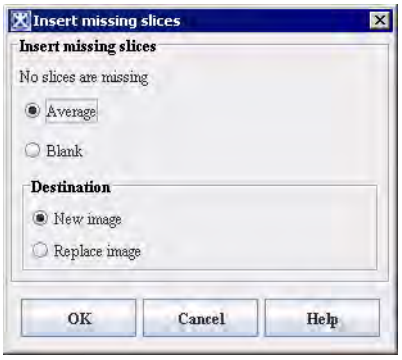


Figure 271. The Insert Missing Slice dialog box options

Inserting slices into image datasets

When you change an image dataset, you are inserting or removing slices in the dataset or changing their order.

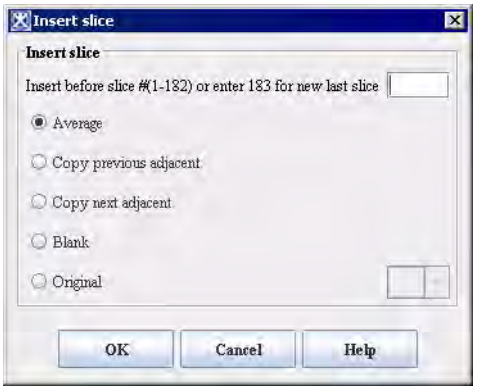
You can use the Insert Slice command on the Utilities menu to insert a slice into an image dataset. Although you cannot insert a slice from another file, you can insert either a blank slice or a new slice that is an average of two adjacent slices in the dataset.

To insert slices into image datasets

1. Select Utilities Slice Tools> Insert Slice. The Insert Slice dialog box appears.
2. Enter the number of the new slice position in the Insert before slice (1-124) or enter 125 for new last slice box.

3 Select either the Average or Blank radio button. If you select Average, MIPAV analyzes the slices immediately before and after the new slice in the dataset. The software then generates an intermediary composite by morphing the two slices. This composite becomes the new slice. If you select Blank, MIPAV inserts a blank slice in the dataset.

4 Click OK. MIPAV inserts the new slice into the dataset and opens the new dataset in a new image window.



Insert before slice (1-124) or enter 125 for new last slice	Specifies the position of the new slice.
Average	Inserts a slice that is the average the adjacent slices.
Copy previous adjacent	Insert a slice that is a copy of the preceding slice.
Copy next adjacent	Inserts a slice that is a copy of the following slice.
Blank	Inserts a blank slice.
Original	Inserts an image from the original dataset.
OK	Applies the parameters that you specified to insert the slice in the image dataset.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not insert the slice into the image dataset.
Help	Displays online help for this dialog box.

Figure 272. The Insert Slice dialog box options

Pad slices to power of 2

The utility pads an image with blank slices to an even power of 2 (e.g. 2^{2k}). Depending on the selected option (Pad to Front, Pad to Back, or Pad to Half Front and Back), all slices can be inserted in front, in back, or half the slices in front and half the slices in back.

IMAGE TYPES

The algorithm works with 3D and 4D, grayscale, black and white, and color images. It preserves the image type when inserts slices.

APPLYING THE PAD TO POWER OF 2 UTILITY

To pad the image dataset to power of 2

1. Select Utilities > Slice tools>Pad to Power of 2. The Padding Images dialog box opens.
2. The dialog box window appears indicating how many slices should be added to the image.
3. Choose the method for slice insertion: Pad to Front, Pad to Back, or Pad to Half Front and Half Back.
4. Select the destination. Choose New Image if you want the image with inserted slices appear in a new image frame; choose Replace Image to replace the original image.
5. Click Pad to proceed.

Pad to Front	Inserts slices before the first slice of the image.
Pad to Back	Inserts slices after the last slice of the image.
Copy previous adjacent	Insert a slice that is a copy of the preceding slice.
Destination	
Pad to half front and half back	Inserts half of the slices before the first slice of the image and half after the last slice.
New Image	Opens the modified image in a new image frame.
Replace image	Replaces the existing image.
Pad	Applies the parameters that you specified to insert the slices in the image dataset.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not insert the slice into the image dataset.
Help	Displays online help for this dialog box.

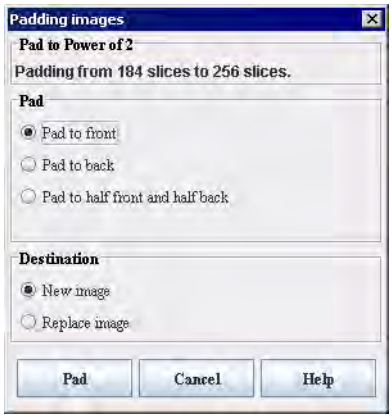


Figure 273. The Padding Images dialog box options

Randomizing image (slice) order

To randomize the order of slices in the image dataset, do the following:

1. Open an image that contains slices.
2. Write the slice numbers on a piece of paper.
3. Select Utilities > Slice Tools>Randomize Slice Order.
4. The MIPAV window refreshes and, depending on your selection, the new dataset appears in the same image window as the original dataset.

The new randomized slice ordering appears as a table in the Output window.

Removing images (slices) from datasets

MIPAV allows you to remove one, several, or all slices from an image dataset. In addition, you can specify one or more ranges of slices to remove, or slice removal can include only the even-numbered or only the odd-numbered slices.

To remove slices from datasets

1. Select Utilities > Remove slices. The Remove Slices dialog box opens.
2. Use the image slider in the MIPAV window to locate slices that you want to remove.
3. Decide whether to remove:

   - One or more slices
   - Most of the slices
   - One or more ranges of slices
   - All even-numbered slices
   - All odd-numbered slices

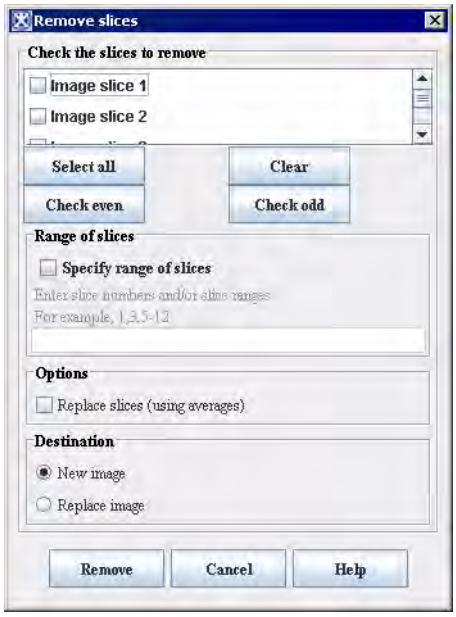
Tip: Use the image slider on the MIPAV window to look at specific slices to decide which slices to remove.

4. Select one of the following:

   - *New image*—If the new image dataset should appear in its own image window
   - *Replace image*—If the dataset should overwrite the original dataset and appear in the original image window

5. Select Remove. A status message appears. Then the MIPAV window refreshes and, depending on your selection, the new dataset appears in either a new image window or in the same image window as the original dataset.

Slices	Indicates the slices that you want to remove from the dataset. You can scroll through the list to select one or more slices.
Select all	Selects all of the slices in the dataset.
Clear	Clears all of the slices that are currently selected.
Check even	Selects all of the even-numbered slices.
Check odd	Selects all of the odd-numbered slices.
Specify range of slices	Indicates that you want to remove one or more slices or a range of slices from the dataset. If you select this check box, you must specify the slices or ranges of slices you want to remove. in the Slice number or range of slices box below.



Replace slices	If you select that option, the removed slices would be replaced using the average method.
New image	Shows the results of the slice removal in a new image window.
Replace image	Replaces the current active dataset with the dataset resulting from the slice removal in the same image window.
Remove	Removes the slices that you indicated in this dialog box.
Cancel	Disregards any changes that you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 274. Remove Slices dialog box

Replace blanks with averages

The algorithm replaces blank slices with slices that carry average pixel values calculated from the neighbor slices. The algorithm, first, counts the

number of consecutive blank slices, and then does the following:

1. If the consecutive slices are at the beginning of the image, the all replaced with the first nonblank slice.
2. If the consecutive slices are at the end of the image, they all replaced with the last nonblank slice.
3. If the consecutive slices are somewhere in the middle, they replaced by the weighted sum of the surrounded nonblank slices.

Example: for a single blank slice, the pixel values are replaced by the averages of two surrounding slices. For two consecutive blank slices, the pixel values for the first slice are calculated as (2/3 * bottomNonBlank + 1/3 * topNonBlank); and for the second blank slice, the pixel values are calculated as (1/3 * bottomNonBlank + 2/3 * topNonBlank).

To run the algorithm, call Utilities >Slice Tools> Replace Blanks with Averages.

IMAGE TYPES

The algorithm is only applicable for 3D, grayscale images.

Replace Slices

For 3D and 4D images, the algorithm allows to replace image slices with some other slices (2D) chosen by a user.

TO APPLY THE REPLACE SLICES ALGORITHM,

1. Open an image of interest (3D or 4D).
2. Move the image slider so that it shows the slice that you wish to replace.
3. Open the 2D image that you would like to put in place of the chosen slice.
4. Call Utilities>Slice Tools>Replace Slices.

5 In the dialog box that appears, indicate the slice number that you would like to replace.

6 Press OK. The algorithm replaces the selected slice with the chosen 2D image. See Figure 275.

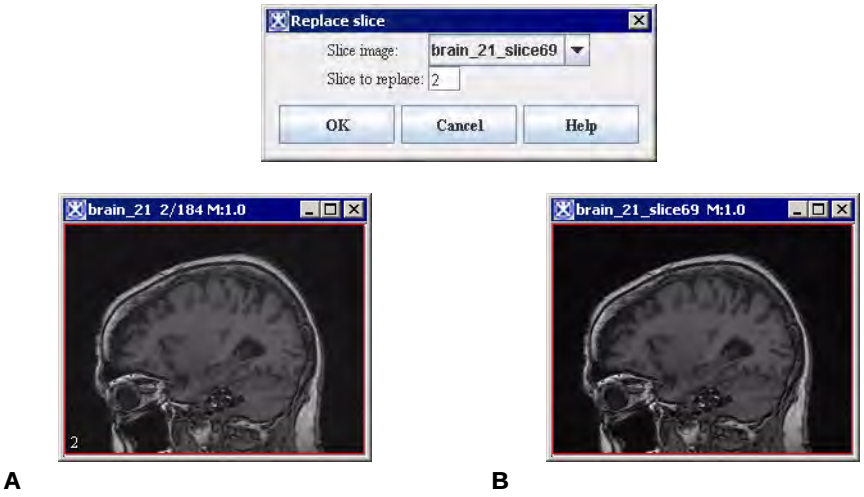


Figure 275. The Replace Slice dialog box (at the top), the original image (A), and the image (B) that was used to replace the slice 2 of the original image

IMAGE TYPES

The algorithm is applicable for both grayscale and color 3D images. The image that you use to replace the slice must be 2D.Note that the type of the original image and the image that you use to replace the slice must be the same. E.g. you cannot replace the grayscale slice with the color image.

Subtract VOI Background

The Subtract VOI Background algorithm subtracts the mean or median value of a VOI from the image. If only one contour is present, that contour is used whether or not it is selected. If multiple contours are present, at least one contour must be selected, and only selected contours are used.

Note: that under MIPAV all selected contours must belong to the same VOI.

IMAGE TYPES

The algorithm is applicable for any 2D, 3D, 4D, color and grayscale images. If the new image exceeds the range that can be stored in an image of that type, the data is either clipped and stored in the original image (Clip mode). Or a new image of a type (int, float...) that can store the range of new data is generated (Promote Image Type mode).

For color images, the dialog box currently disables promotion for color because MIPAV cannot handle negative color values.

Recommendation: To learn more about Clip and Promotion modes, see also "clip mode" on page 418 and "promotion mode" on page 418.

Applying the algorithm

To apply the Subtract VOI Background algorithm do the following:

1. Call Utilities>Subtract VOI Background.
2. In the dialog box that appears, select either Median or Mean.
3. Specify the clip mode.And specify where you want the new image to appear – in the new image frame or in the same frame, replacing the old image.
4. Click OK. The algorithm begins to run and the new image appears in the chosen destination.

Average type	
Mean	Uses mean values to calculate average VOI background.
Median	Uses median values to calculate average VOI background.
Clip	Select this option if you want the result image to be clamped at the maximum (minimum) value of Image A data type. See also “clip mode” on page 418.
Promote	When this mode is selected and the result value is out of the legal range of Image A data type, then the result image type is promoted to a new data type with a data type range capable of expressing the minimum and maximum values. See also “promotion mode” on page 418.
New Image	Opens the modified image in a new image frame.
Replace image	Replaces the existing image.
OK	Runs the algorithm.
Cancel	Disregards any changes you made in this dialog box and closes the dialog box.
Help	Displays online help for this dialog box.

Figure 276. The Subtract VOI Background dialog box options