



Physics MRI Research Centre

ACCISS 10
MRI Analysis Package
User's Guide

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Table of Contents

Acknowledgements	2
Introduction.....	3
Scope	3
Functionality Summary	3
Running ACCISS.....	3
The ACCISS Interface.....	4
The 1D Window	4
The 2D Window	5
The 3D Window	6
The 2D Slicer.....	7
Other Interface Notes	8
The ACCISS Menu Commands.....	9
File Menu	9
Fourier Menu.....	9
1D Image Menu.....	10
2D Image Menu.....	10
3D Image Menu.....	10
Extras Menu	10
Fourier Transforms	11
Chirp Z-Transforms	12
Making Animations	13
Overview	13
Control Commands.....	13
2D Animation Commands.....	14
3D Animation Commands.....	14
About the STEP Option.....	15
Sample Animation Scripts.....	15
Miscellaneous Notes.....	15

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Introduction

Scope

ACCISS is designed to facilitate and centralize the common kinds of image processing tasks being performed at the UNB MRI Centre, such as Fourier transformation of signals from the three primary spectrometers, manipulation of 2D and 3D datasets, and creation of images suitable for publication. It generally does not implement special functions that would be specific to a single experiment or a single person's research.

Functionality Summary

ACCISS is outfitted to provide a wide range of image and signal analysis functions. The software can currently do the following:

- Read most files generated by the DRX, Apollo, Libra and GE spectrometers
- Perform Fourier transforms in up to three dimensions with a variety of options, including filtering, and zero filling, as well as a choice of which dimensions to transform
- Perform Chirp Z-Transform on a dataset or a series of images in up to three dimensions with a variety of options, including a selection of the number of time points being processed, baseline correction, as well as a choice between doing a simple CZT and averaging all points to increase SNR.
- Generate a 3D view of a dataset that can be interactively rotated or magnified
- Extract and display arbitrary 2D image slices from the transformed 3D dataset
- Extract 1D X and Y profiles from a 2D image or slice, and save them to a file
- Create animations of 2D or 3D data.
- Selectively view real, imaginary, magnitude and phase angle data channels
- Combine multiple files into a single unit for bulk analysis purposes
- Save a transformed/processed dataset so it can be closed and re-opened later or used in another program.
- Copy image displayed in the main window to a new window for comparison purpose.
- Save images in TIFF, JPEG, or PIC formats

Running ACCISS

ACCISS was developed under Mathworks Matlab Programming Environment. Normally, Matlab would need to be installed with a valid license to run ACCISS with the m-file. Another option is to launch a compiled Standalone application from Matlab. To be able to launch a Standalone application from Matlab the correct MCR that matches the version of Matlab that ACCISS was compiled with has to be installed on the target computer. You find the MCRs to download from the Mathworks site. <http://www.mathworks.com/products/compiler/mcr/>.

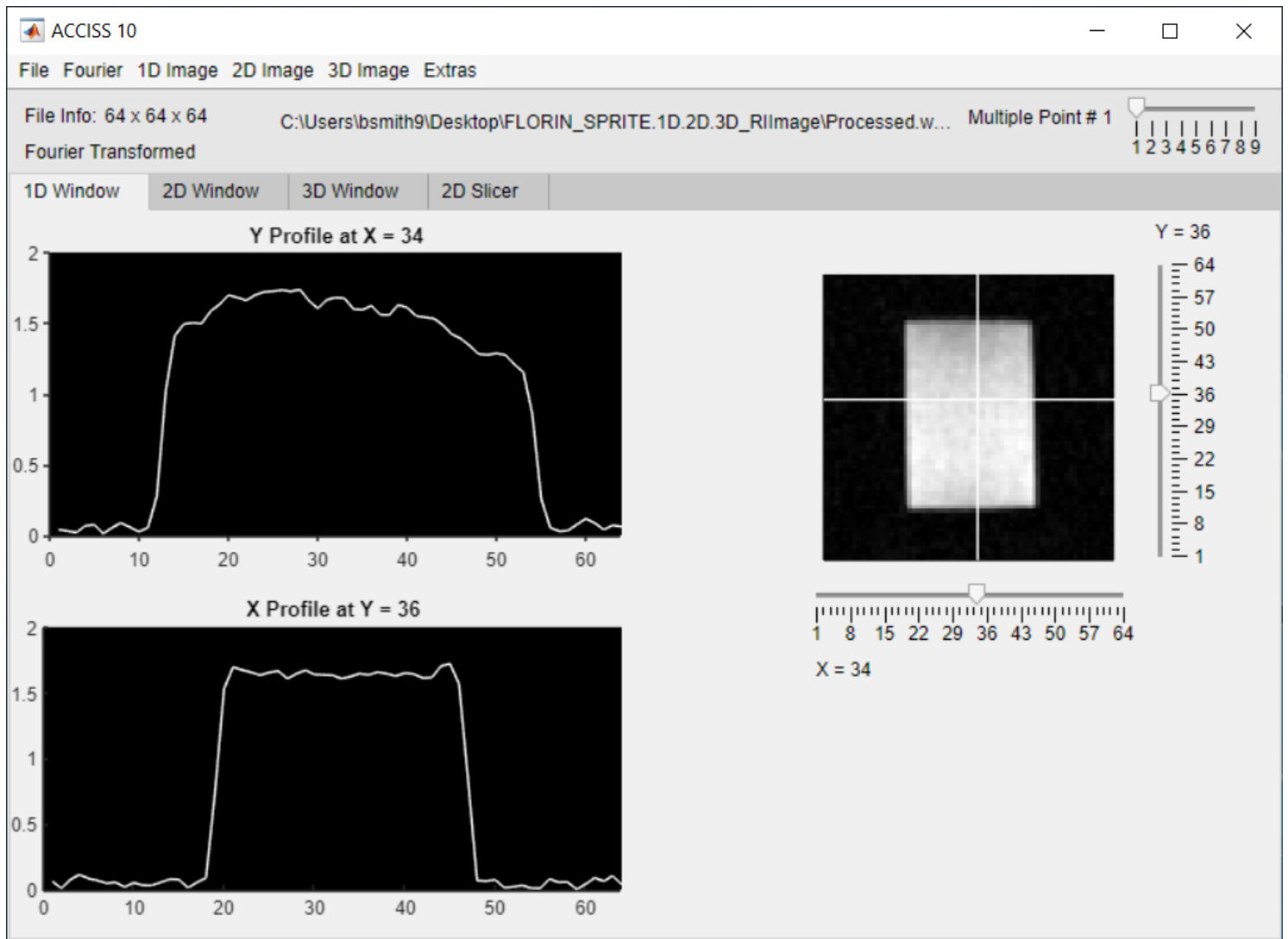
The ACCISS Interface

This section describes the functionality of each of ACCISS's four main graphics windows. The user can switch between these windows by clicking the tabs at the top of the screen.

The 1D Window

This window is used both for displaying 1D files (such as half-K space acquisitions and bulk T2 measurements) and examining profiles of 2D and 3D datasets. In the former case, it contains only the graphics window itself, since all of the operations that can be performed on such data are covered in the menu commands, or elsewhere in ACCISS.

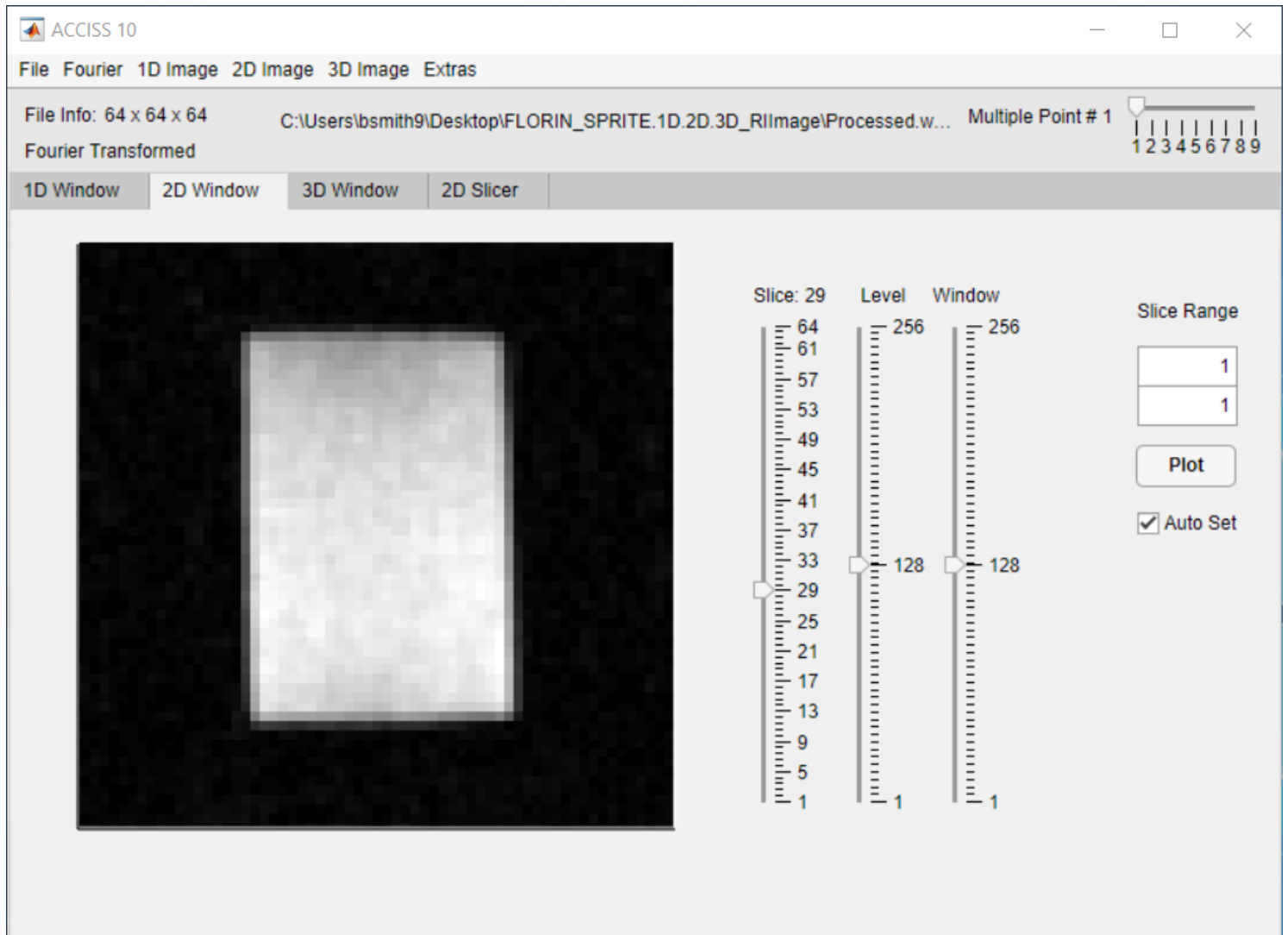
However, for 1D images generated from extracting profiles of a 2D or 3D dataset, there is an additional small window and two sliders that graphically illustrate the location of the two profiles being viewed. The user can click on the sliders or on the small window to select new profiles to display in the main window.



The 2D Window

This window displays 2D images and orthogonal slices from 3D datasets. A wide variety of commands are available to adjust the type of image being displayed; for more details on these commands see the “2D Image” section under “ACCISS Menu Commands”.

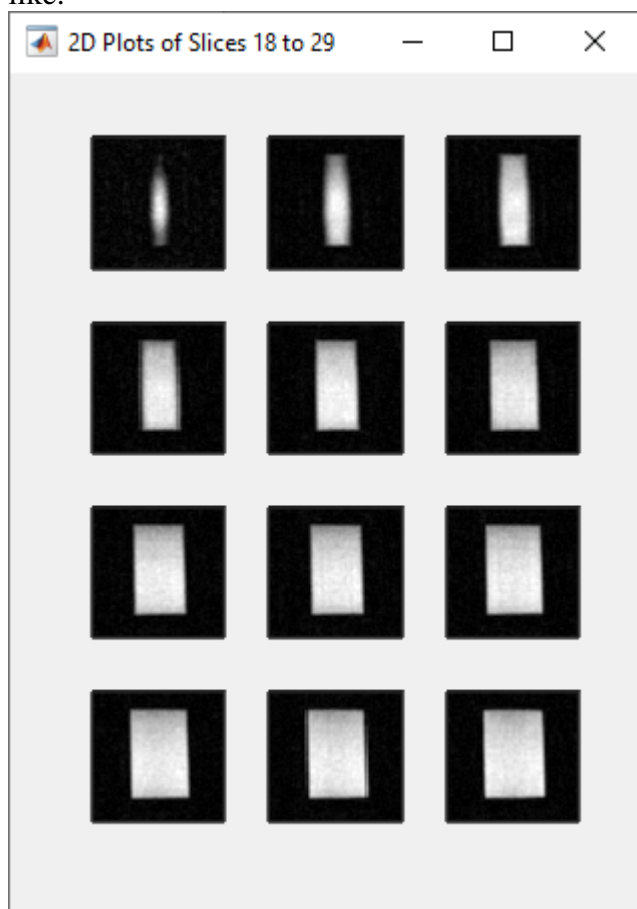
There are also two sliders on the right side of the screen to adjust window and level (contrast and brightness) and a third slider to move through the third dimension of a 3D dataset.



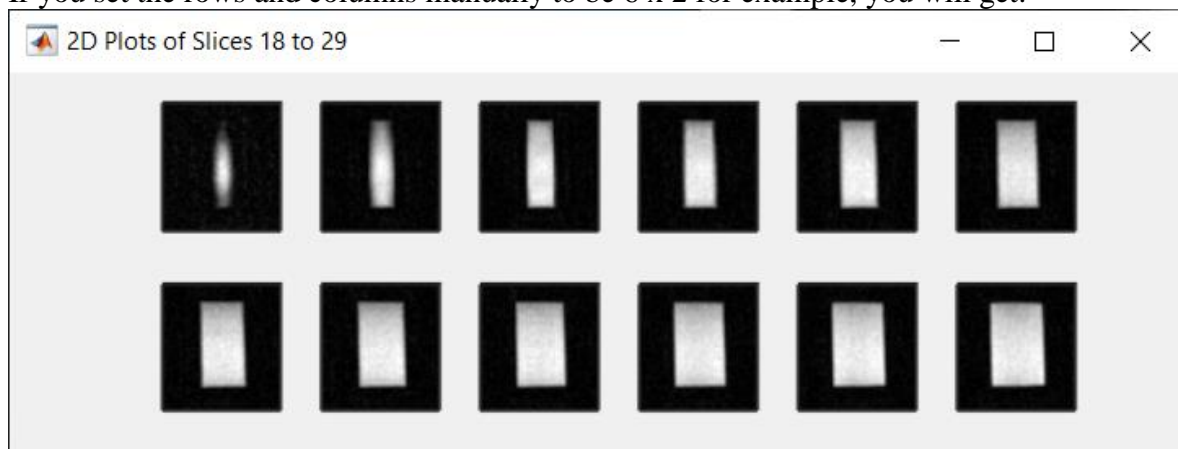
Range of Slices Viewer

On the right column, there are various options for displaying a range of slices as opposed to just one like on the left. The first and second boxes are first and last slice to view, inclusive. This will open a new window, and refresh that same window with new settings when you hit “Plot”. You can also set the rows and columns manually. On automatic, it will try and keep the dimensions as close as possible but with no extra white rows. These images will listen as well to the ‘Level’ and ‘Window’ sliders to their left.

With the settings above (slices 18-29 and automatically set row/ columns) you will get a new window that looks like:



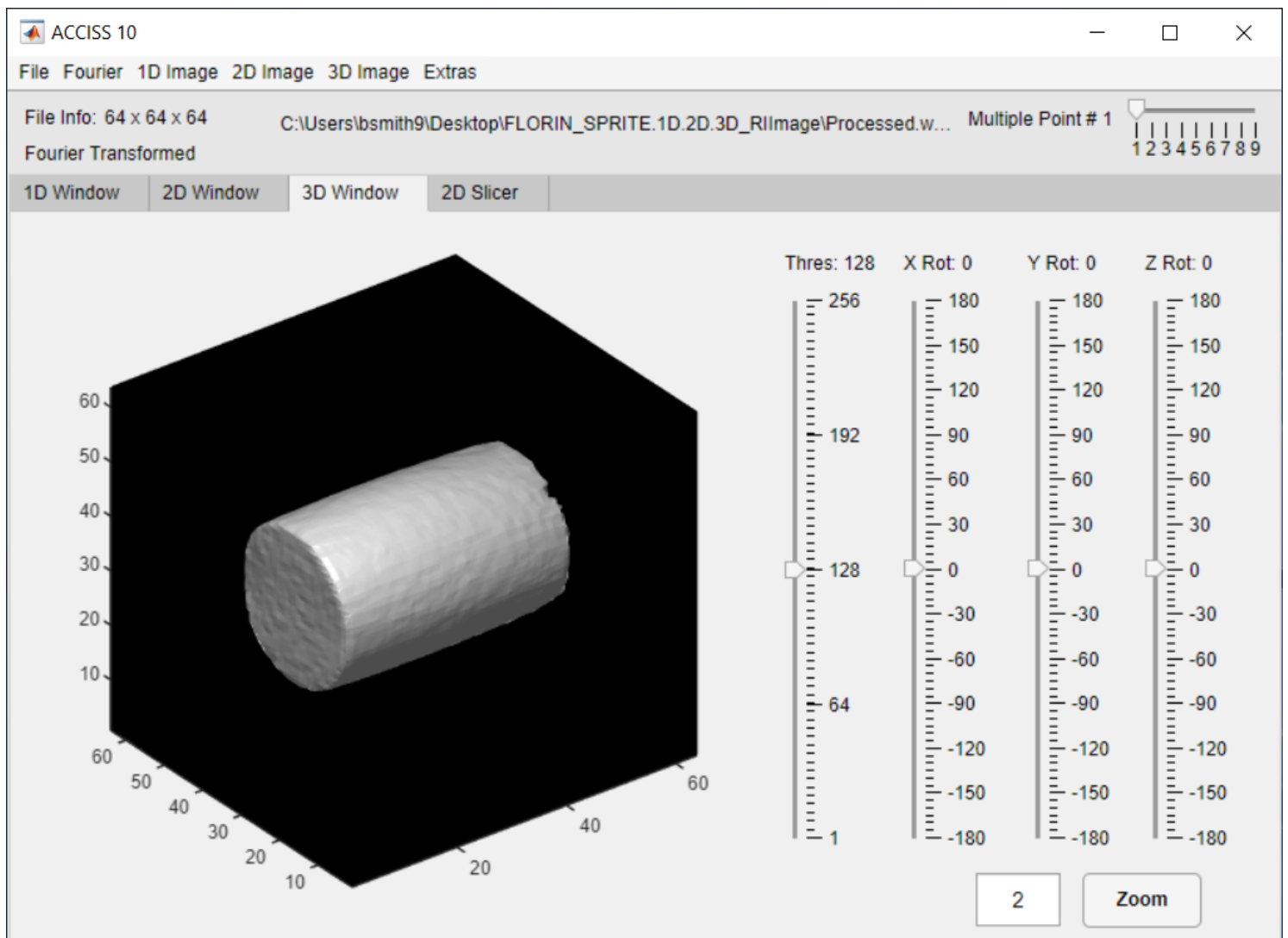
If you set the rows and columns manually to be 6 x 2 for example, you will get:



The 3D Window

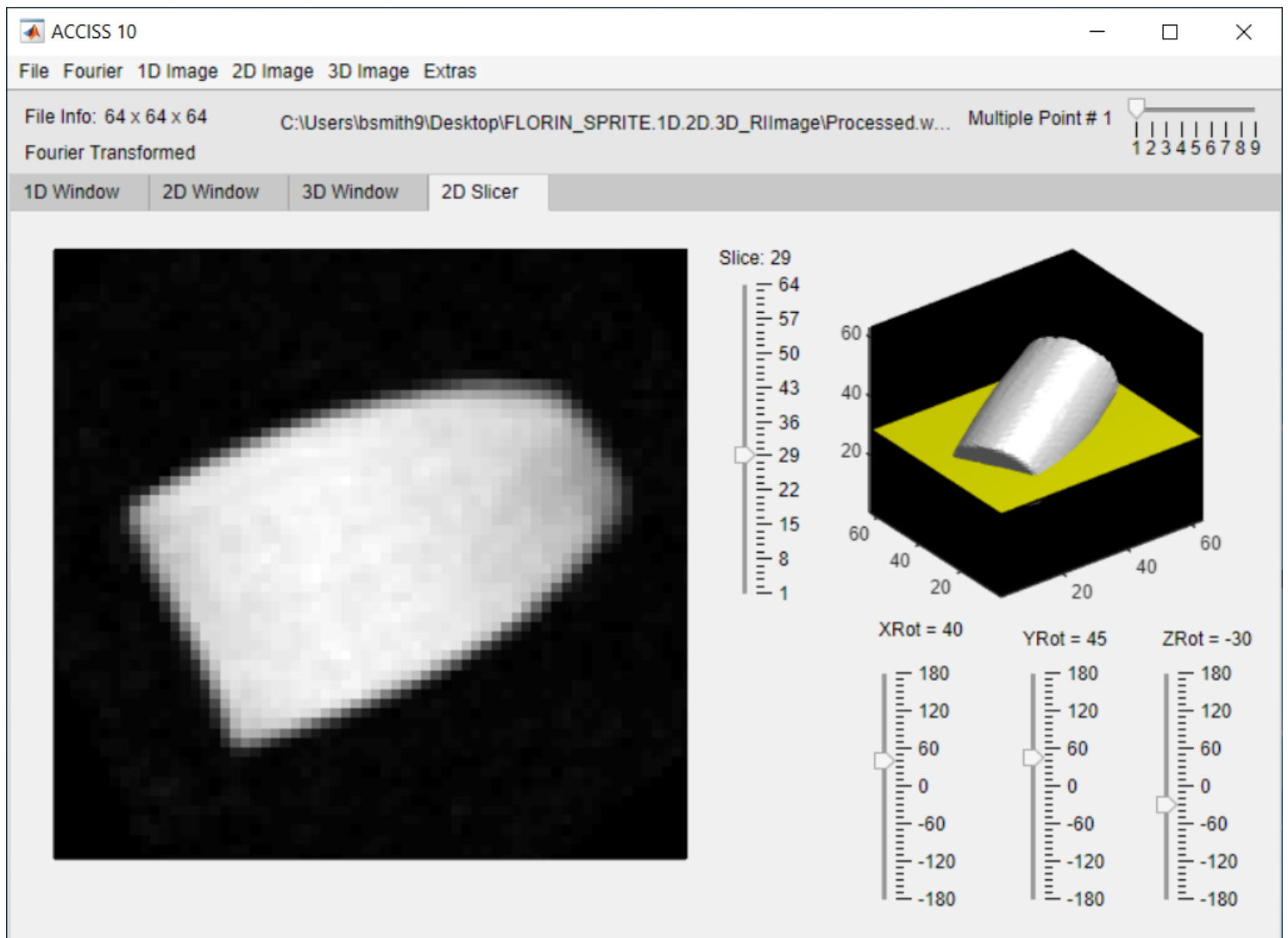
Opening the 3D Window displays a rendered 3D model of the current (Fourier-transformed) dataset. This model can be rotated in three dimensions with the X, Y and Z rotation sliders to the right of the main display window. The threshold slider controls how much of the image is displayed; any pixels with intensities higher than the threshold appear on the model, and those with intensities below the threshold are ignored. The Zoom entry field on the bottom right can take values between 0.1 and 10 and the “Zoom” button applies that magnification value. Zooming can also be done on any image in ACCISS using the in-axis control buttons (see SOMETHING INPUT HERE)

Some other controls for manipulating the 3D image are available from the menu (see below for details).



The 2D Slicer

The 2D Slicer is used to extract arbitrarily oriented slices from a 3D volume; that is, slices that are not necessarily parallel to the coordinate axes. The object is oriented with the three rotation sliders on the lower right. A slice is extracted by clicking on the small window or on the nearby fourth slider. The slice shown in the large window is what would appear if the top of the volume were cut away along the white line in the small window.

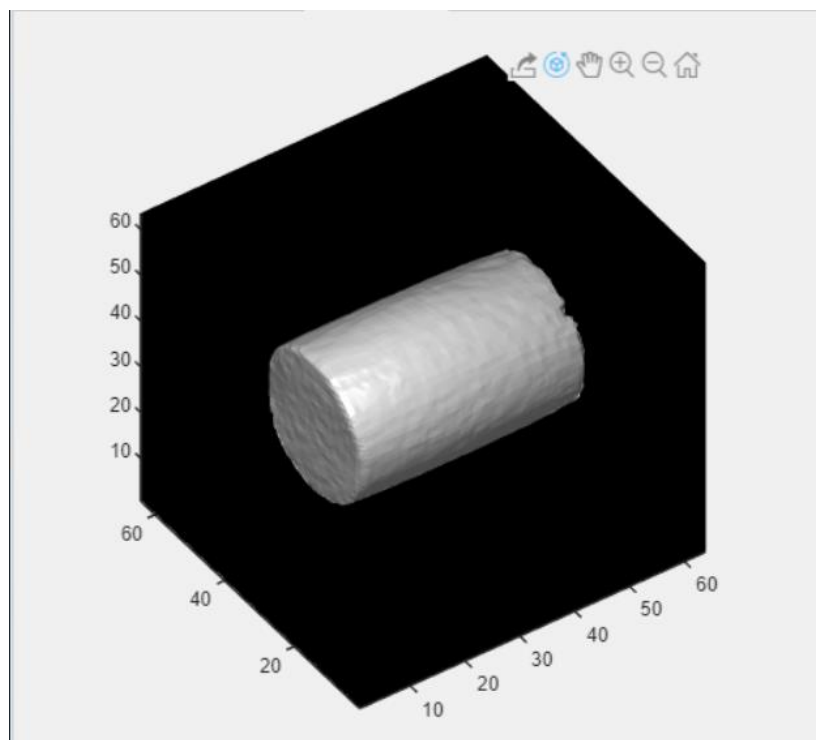


Axis Image functions

MATLAB Axis' now contain image manipulation functions that can be very useful, however they are not linked to the rest of the program, so when any slider values are changed these manipulations will be reset. This is to preserve consistency

In order as they appear from left to right:

- Saves the current image to a .tiff or .jpeg file format
- allows for 3D rotation of the axis (only available in a 3D axis).
- allows for sliding of the axis along the x and y plane.
- zooms in on the image.
- zooms out on the image.
- resets the image to fill out the graph, this tends to round limits to multiples of 10, and to stretch 3D objects to fill the image screen in unnatural ways. If trying to reset an image it is best to use the "Reset Sliders" option in the "Extras" menu.



Other Interface Notes

- Obviously, not all of these graphics windows are available for each kind of file. For example, when viewing a 2D file it is not possible to use the 3D Window or the 2D Slicer.
- The Multiple Point slider on the top right allows to switch between different points, if multiple files are selected the name of the file displayed will be adjusted when this slider is adjusted.
- The options in the menus for each graphics window are not always enabled; they only become active when the window to which they are linked becomes visible.
- The panels at the top of the screen contain information on the current file, including its dimensions and whether it has been Fourier-transformed or Chirp Z-transformed.

The ACCISS Menu Commands

This section provides a brief overview of the function performed by the menu commands available in ACCISS 10. More information on the details of these commands may be found in other sections of this User's Guide.

File Menu

Open

Loads a .dat, .tnt, .riimage or .csv file into the program. (Note only .csv files created by ACCISS can be loaded as they follow a specific convention. The image will then be loaded into the appropriate display window. If the file type can be determined from the file's extension, and it loads properly, you will not have to specify the file type; otherwise the program will ask you what type of file it is.

Note that you can now open multiple files through this dialog, rather than with the "Multiple Open" command which was in previous versions of ACCISS. On most operating systems, you use the *Ctrl* and/or *Shift* keys to select more than 1 file. The set of files are treated as a unit after they are loaded; for example, a number of 1D files can be combined to make a 2D image or multiple 2D images can be combined to create a 3D dataset. All the files must be the exact the same size for this to work.

Open then FT

Same as Open except a Fourier Transform is immediately done, using the standard options. This option can be especially handy if you have a large file, because you could get all the processing started with 1 command, then go away and wait while it loads then gets transformed.

Save

This sub-menu contains commands to save the current dataset (K-space or Image-space) in a special format that can be re-opened by ACCISS later. Files can be saved as byte data or as a csv. You can also save all images of multiple acquisition point dataset so that these images can be used to create an animation file later. Saving of the images in a .jpeg or .tiff format is now supported by the in axis functions (see THE THING I NEED TO ADD)

Close File

Closes the current file and resets all graphics windows and parameters associated with that file but does not quit ACCISS. Note if you're about to open another file, you do NOT need to close the current one first; that is done automatically.

Recent Files

This menu entry contains a list of the last five files opened by ACCISS. Note that it does not hold entries corresponding to 'multiple file open' operations, so if you expect to be combining the same set of files repeatedly, it might be best to open the whole set once and then save it in the special ACCISS format for quick access later.

Quit

Exits ACCISS

Fourier Menu

Simple FFT

Does a fast Fourier transform without bringing up the options dialog. Just like the “Open then FT” command. Also like that command, it always Fourier transforms every dimension.

FFT with different options

Brings up the Fourier transform options dialog so the user can select exactly what kind of Fourier transform they want to do and then do it. This is the main command in the Fourier menu. See below for an explanation of the dialog.

Chirp Z Transform

Brings up the Chirp Z-Transform options dialog so the user can choose exactly how the Chirp Z-Transform can be done and then do it. See below the “Chirp Z-Transform” part for a detailed explanation of the dialog.

1D Image Menu

Normalization

Toggles normalization of 1D plotting and profile axes. When enabled, all values in the plot are divided by the maximum value, so the range is from 0 to 1. (Note that this does not make any changes to the data itself, just the plot axes.)

2D Image Menu

Axis

In a 3D dataset, selects the axis controlled by the “slice” slider bar. The default is the Z axis, which means that the X and Y directions are displayed in the graphics window, and moving the “slice” slider moves up or down through the Z direction.

Resolution

Sets the resolution to “pixelated” or “smoothed”. Pixelated images are generated by nearest neighbor sampling while smoothed images use bilinear interpolation.

- Pixelated: Use nearest neighbor sampling for both magnification and minification. Bilinear interpolation gives higher quality results but requires more time.
- Smoothed: Use bilinear interpolation when magnifying and neighborhood averaging when minifying.

Display

Allows display of the magnitude, real, imaginary or phase angle channels of the currently displayed 2D image.

2D Animator

Opens the 2D Animator dialog box. See “Making Animations” for more information.

3D Image Menu

Light Source

Open a dialog that allows repositioning of the 3D light source. This let the rendered 3D object appear to be lit from different angles.

3D Animator

Open the 3D Animator dialog box. See “Making Animations” for more information.

Extras Menu

Colour Map

Sets the colour map for 2D images as either Grayscale (default), Grayscale inverted, Parula (MATLABS default), or jet.

Copy to New Window

Open the currently displayed image into a new floating window. This window stays open even when the main view is changed or the current file is closed; this allows the comparison of images with different parameters or from different files.

Reset Sliders

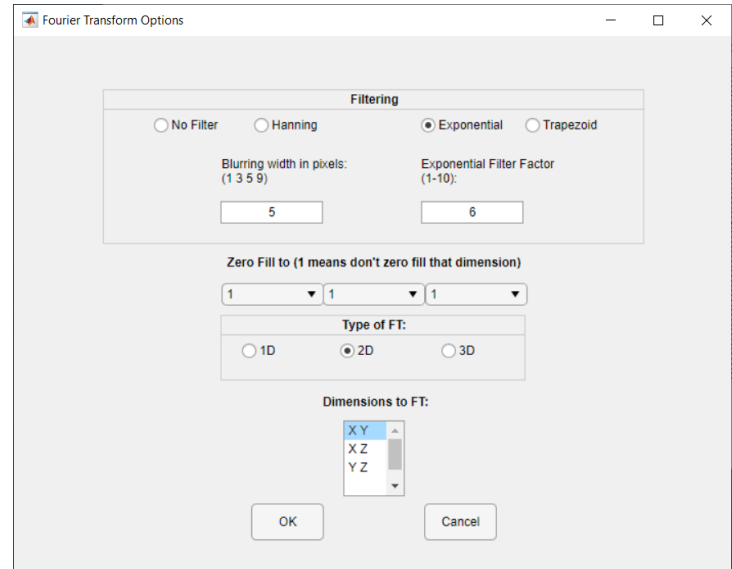
Resets all the sliders in ACCISS back to their default positions.

Fourier Transforms

Perhaps the most common operation performed by users of ACCISS is a Fourier transform, without which most of the images we study would remain inscrutable. ACCISS allows quick and easy transforms in up to three dimensions, with a wide variety of options. This section will describe those options and how they affect the appearance of the final image.

The dialog box shown on the right is the main Fourier transform options dialog. This allows the user to configure the options differently each time they perform a transform. If several transforms are to be performed with exactly the same options, the user can set them once and then keep the dialog box from appearing again, if they wish.

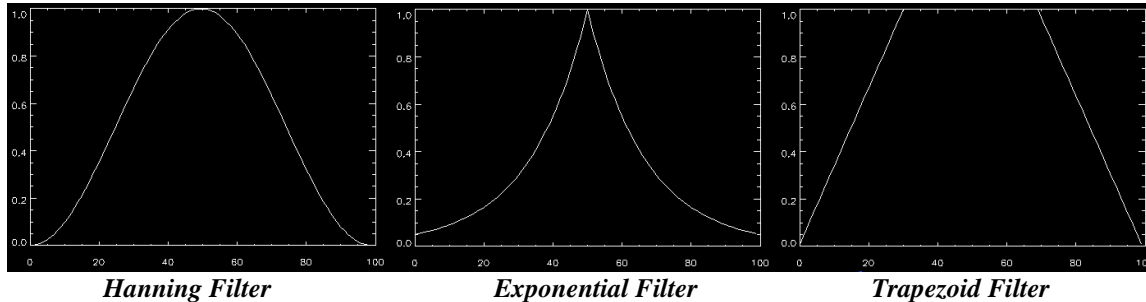
Note that, once a file is Fourier-transformed, it does not need to be re-loaded if you wish to try a different set of transform options. Just use the appropriate transform command again (with the option “Transform original data” set, which is set by default), with a different set of options, and ACCISS will re-transform the K-space data.



Here is an explanation of the individual options:

Filtering

- The three types of filter available are Hanning, Exponential and Trapezoid. Examples of each type of filter are shown in the figure below.
- All three filters emphasize the middle part of a dataset and reduce noise along the extremities to some degree. The differences lie in the actual shape of the filter being used.



Blurring width in pixels

- This option only appears when you've selected exponential filtering.
- This number corresponds to an exponential filter factor that will cause the specified blurring width in pixels. By default, this number is 5, which corresponds to an exponential filter factor of 6. If only blurring width is specified, the corresponding exponential filter factor is used for exponential filtering. If only exponential filter factor is specified, this value will be used to perform exponential filtering. If both blurring width and exponential filter factor are specified and these two values are not consistent according to the internal mapping rule, you will be asked to select one of them to perform exponential filtering.
- You will be able to predict the effect of blurring if you specify this value.

Exponential Filter Factor

- This option only appears when you've selected exponential filtering.
- This number determines the shape of the exponential filter; as noted in the dialog box itself, this is typically an integer between 1 and 10, though it does not have to be.
- This value determines how quickly the exponential filter approaches zero at either end.

Trapezoid Filter Inputs

- Start of Trap Filter describes the point at which the incline describing the trapezoid begins (between 0 and 50%)
- Peak of Trap Filter describes the point at which the incline describing the trapezoid reaches the peak (between 1 and 50%)
- These points describe the points describing the decline inversely

- Values before Start will be zero, values after peak will equal 1, and values in-between will be in-between sloping upwards until 50% where the mirror will take place.
- For example, a peak of 50 would describe a triangle filter, or a start = peak would describe a rectangle
- Start must be less than or equal to peak, and the application handles this.
- Peak cannot be 0 because then nothing would be filtered

Zero Filling

- Zero filling pads a dataset with zeros to increase the apparent number of points collected and improve resolution of the final image.
- To enable zero-filling in a certain dimension, select a value to zero-fill from the combo box. Any box which contains 1 (which is the default) causes that dimension to not be zero-filled.

Type of FT

Usually, if you have a 3D dataset, for example, you just want to do a 3D transform, because that is the usual procedure to get a 3D image from the raw data. But in some cases, you might want to only transform certain dimensions of the data. A case when this might apply is if you have a set of files that you've opened with Multiple Open and you want to transform each slice individually rather than all the data as a unit. That is what this option is for. If you want to transform 2 dimensions of your data, for example, you set the "Type of FT" to 2D. This way, if you have hundreds of little files that you want to Fourier transform, you can do it all with just a single command rather than transforming them all manually.

Dimension(s) to FT

This option only appears if you select a "type of FT" other than the default. It lets you specify exactly which dimensions to transform.

Chirp Z-Transforms

The command is currently under the Fourier menu. The Chirp Z-Transform is used to perform a z-transform along a special contour in the z-plane, along which the z-transform can be reformulated in terms of a convolution and calculated at high speed using the FFT. A single supplied parameter determines the starting point and angular spacing of points on the contour, and this in turn relates to the field of view of the final image.

Same as Fourier transform, ACCISS allows quick and easy Chirp Z-Transforms of a 1D, 2D or 3D dataset, or of a series of images, with a variety of options. This section will describe those options and how they affect the appearance of the final image.

The dialog box shown on the right is the main Chirp Z-Transform options dialog. This allows the user to configure the options differently each time they perform a CZT transform.

Note that, once a file is Chirp Z-transformed, it does not need to be re-loaded if you wish to try a different set of transform options. Just choose a different set of options, and ACCISS will re-transform the original data. A note will display on top of the dialog box to indicate that the original data will be processed.

Here is an explanation of the individual options:

Choose points to use

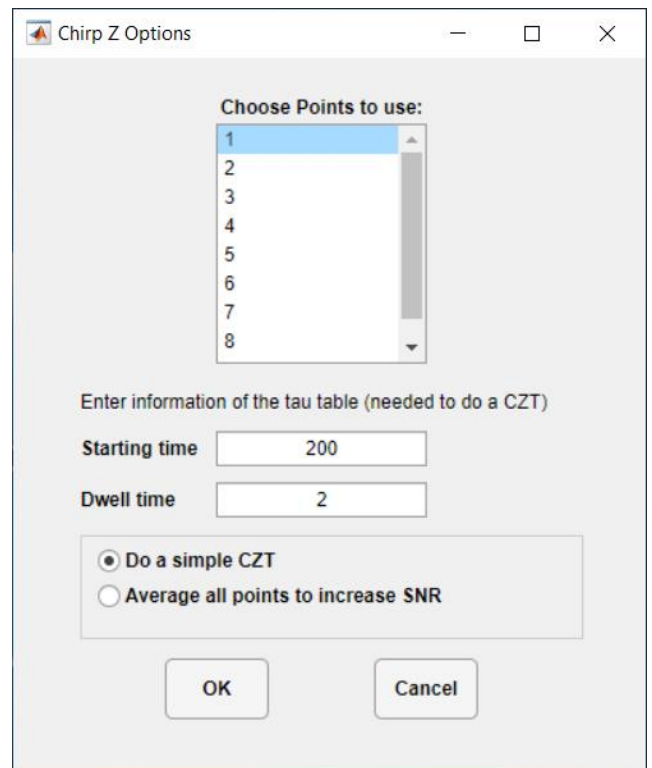
This option lets the user select one or more points to perform a Chirp Z-Transform on the multiple point data.

Enter Starting Time

This option asks the user to provide the starting time to perform a Chirp Z-Transform on the multiple point data.

Enter dwell Time

This option asks the user to provide the dwell time to perform a Chirp Z-Transform on the multiple point data.



[Note: The above three options together determines a single parameter to perform a Chirp Z-Transform on the multiple point data:

- When the input data is a single image, this parameter should be a single floating-point value between 0 and 1 that determines the extent of FOV scaling. It is determined by dividing the image's actual field of view by the desired field of view; this is equivalent to dividing the encoding time of data by the time corresponding to the desired FOV.
- When the input data is a set of images, this parameter should be an array of values, one value for each image, each of which will determine the FOV scaling for that particular image. Again, the values are found by dividing the encoding times of the images by the encoding time of the desired FOV, usually that of the last image in the set.

Do a simple CZT

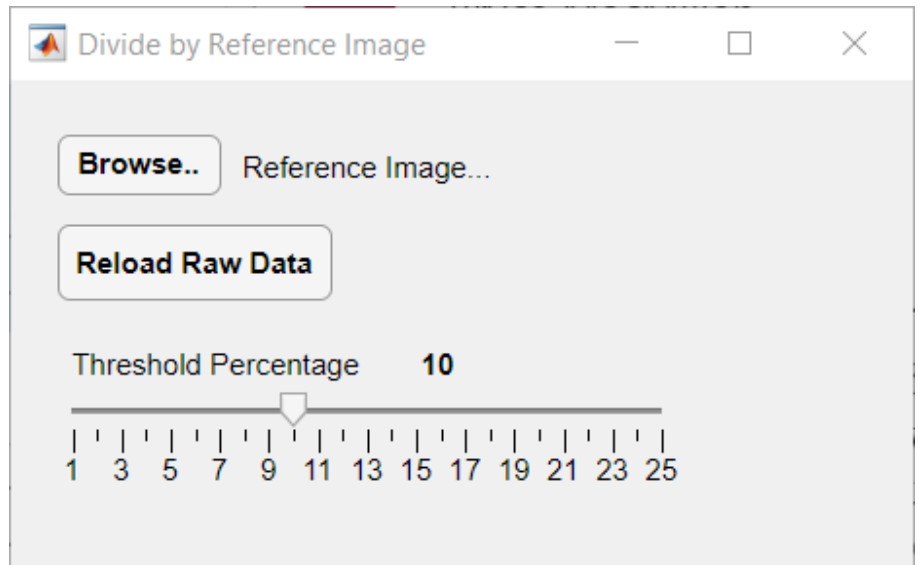
This option will keep the points selected as multiple points which are useful for Fitting. If you chose to do a simple CZT, the multiple points slider bar in the top right corner will show the points you selected. You can move the slider to view individual image.

Average all points to increase SNR

This option will compress all multiple points into 1 point and to improve the signal-to-noise ratio of the final output image.

Reference Image

The Reference Image feature in ACCISS allows us to correct for signal distortions in images which are caused by inhomogeneities in various magnetic fields. When the Reference Image applet is opened whatever data-file is already loaded in, is automatically Fourier transformed. From there the user can select their reference image file and it is processed in the same way as using the “open then Fourier transform” menu would. The first image is then divided by the Reference Image, using a Threshold Percentage parameter, that sets any value under that percentage to 0. The “Reload Raw Data” button will restore the image to its previous state before the division occurred



Making Animations

Overview

The ACCISS Animator module allows for easy creation of QuickTime movies from 3D data. The movie is made up of a series of frames taken from the 2D or 3D graphics window. All the animations are done with scripts, so any number of commands can be executed in sequence and recorded. Scripts can also be saved to disk and loaded later to make new animations. The script language itself is simple and contains only a few core commands to remember.

Scripts are checked automatically before you execute them or when they load to make sure the syntax is correct. Any errors will be reported at the bottom of the dialog box and the script won't run. The “Animate” button will execute the animation. You can watch the results of the animation in the graphics window if you move the animation dialog out of the way.

To make movies from the TIFF-format frames that are generated, an external program such as iPhoto or QuickTime is required. Describing exactly how to operate these programs and create a working movie is beyond the scope of this document.

Control Commands

These commands can be used in either the 2D or 3D animator, and they generally control how the movie is recorded and saved. In the reference below, the syntax [A | B] means that you must add either A or B after the command (though not both).

FOLDER [folderName]

Tells the animator where to save frames of the animation. Note the new option to specify the folder name in the RECORD command instead. FOLDER must be specified before RECORD ON is used. The folder name must be a full path starting with the hard disk name, such as Mac HD:John:Animations. Images are saved as TIFF files with the name "frameXXX.TIF" where XXX is the frame number.

RECORD [ON | OFF | folderName]

Tells the animator whether to save each new frame to an image file. Recording is off by default, meaning that animation commands are executed but the resulting image will not be written to a file. This lets scripts be tested before recording them. Once recording is turned on, every new image produced by the animator will be saved until recording is turned off. The new RECORD folderName command is a shortcut; now you can put:

RECORD folderName

instead of:

FOLDER folderName
RECORD ON

RESET

Resets all parameters to default values. For the 3D viewer, resets all angles to 0, threshold to 128 and zoom factor to 1. For the 2D viewer, displays the magnitude view of the Z=0 slice.

RESOLUTION [res]

Specifies the resolution in which to save the frames. The default is the size of the Acciss2 graphics windows, which is 512x512. Using this command will resize all images to res x res before saving them. This is useful to save disk space.

UPDATE

Updates the screen and saves the current frame if recording is on. This is useful if, for example, you want to say VIEW PHAS on a 2D image and then see what the phase angle view looks like (normally it wouldn't show it until the next command that changes the view, because the VIEW command is usually just to set up the animation).

2D Animation Commands

AXIS [X | Y | Z]

Sets the viewing axis - that is, the axis which would be coming out of the plane of the monitor. Note that the slice number is automatically reset to zero when the axis is changed.

GOTO_SLICE [sliceNumber] STEP [stepNumber]

Displays the specified (orthogonal) image slice along the currently selected axis. The value of the sliceNumber parameter must be between 0 and the size of the dataset in that dimension; setting it any higher will result in an error.

VIEW [MAGN | REAL | IMAG | PHAS]

Selects which portion of a complex dataset is being viewed: MAGN for magnitude, REAL for real part, IMAG for imaginary part, PHAS for phase angle.

3D Animation Commands

ROTATE [X | Y | Z] [BY | TO] [theta] STEP [stepNumber]

Performs a rotation about the desired axis (X, Y or Z). If the BY option is set, the specified angle theta will be added to the current X orientation. If TO is used, the object is rotated until its angle with respect to the selected axis is theta. Use negative angles to rotate counterclockwise.

THRES [UP | DOWN | TO] [value] STEP [stepNumber]

Affects the intensity threshold value of the 3D image. Any pixels with intensities above the threshold are displayed, pixels with intensities below the threshold are not displayed. Using

UP adds the specified value to the threshold, down subtracts the specified value, and TO raises or lowers the threshold until it reaches the desired level.

ZOOM [IN | OUT | TO] [zoom] STEP [stepNumber]

Changes the zoom factor, which is 1 by default. High factors mean higher magnification of a 3D object, so using ZOOM IN will increase the zoom factor by the specified amount, and ZOOM OUT decreases it. ZOOM TO moves the zoom factor up or down until it reaches the specified value.

About the STEP Option

This option is added to some of the animation commands to tell the animator how often to create a new image. For example, when doing a 90-degree rotation, setting STEP 5 will create a new image every 5 degrees, for a total of 18 images. Larger step values will result in smaller but jerkier animations. If STEP is not given, the animator goes directly to the desired position, which is useful for properly orienting the object prior to beginning animation.

Sample Animation Scripts

```
\ Sample 2D animation script
\ Starting from Y=31 slice, steps backward to Y=0
\ Then switches to Z axis phase angle display
\ Goes to Z=31 slice, showing every other slice
RESET
AXIS Y
GOTO SLICE 31
FOLDER Mac HD:John:Animations
RECORD ON
GOTO_SLICE 0 STEP 1
AXIS Z
VIEW PHAS
GOTO_SLICE 31 STEP 2
RECORD OFF
```

```
\ Sample 3D Animation script
\ Rotates a thresholded object 360 degrees around Z
\ Rotates X to 90, zooms to 1.0, finishes rotating X to 180
\ All images saved in 256x256 resolution
RESET
THRES TO 80
FOLDER Mac HD:John:Animations
RESOLUTION 256
RECORD ON
ROTATE Z BY 360 STEP 10
ROTATE X TO 90 STEP 10
ZOOM IN 0.3
ROTATE X BY 90 STEP 10
RECORD OFF
```

Miscellaneous Notes

- You can only put one command per line, though not every line must have a command.
- The backslash “\” denotes comments; all characters up to the end of the line are ignored.
- Comments must be there own separate lines
- Parameters and options should be separated from the command itself by a single space.
- New animations will overwrite any that already exist in the target folder.