

WFU_DICOMtk v1.0

ANSIR Laboratory
Wake Forest University School of Medicine

REQUIREMENTS:

MATLAB6.5 or greater with the Image Processing Toolbox
SPM2 or SPM5

FUNDING:

R01EB004673 under the Human Brain Project and NIBIB



WAKE FOREST
UNIVERSITY

SCHOOL of MEDICINE

Software Description

The WFU_DICOMtk software package converts 3-D image volumes or 2-D images to DICOM format and optionally sends them to a PACS server. It may also serve as a DICOM image viewer. The scripts are written entirely in MATLAB. The images input for DICOM conversion may be either 3-D volumes readable by SPM or any 2-D images supported by MATLAB's `imread` function. The software was developed in the ANSIR Laboratory at the Wake Forest University School of Medicine. Questions can be referred to:

maldjian@wfubmc.edu

Download

WFU_DICOMtk is available from the Software Downloads link here:

<http://www.fmri.wfubmc.edu>

Installation

On Windows, unzip the *.zip file. On UNIX, `gunzip` and `untar` the *.tar.gz file. The extracted files will be in a directory named `wfu_dicomtk`. Installing `wfu_dicomtk` within the SPM toolbox directory allows the program to be started from the SPM GUI drop-down menu. When installing elsewhere, set the `wfu_dicomtk` directory as the topmost MATLAB path and start the program at the command line by typing:

```
wfu_dicomtk
```

Compatibility

WFU_DICOMtk requires MATLAB version 6.5 or greater. To read Analyze volumes, SPM2 or SPM5 is required. To read NIFTI volumes, SPM5 is required. Structural displays with or without a fused overlay may be output to an image volume with either SPM2 or SPM5. This software has been tested in MATLAB on Windows, Linux, and Solaris. Sending DICOM files to a PACS server is enabled only under Linux and Solaris.

History

This suite of MATLAB programs is based upon the WFU DICOM IDL Toolkit.

How It Works

The WFU_DICOMtk package can fuse structural and functional images, generating DICOM files from the non-color fused image. If the first DICOM image from which the structural image volume (Analyze or NIFTI) was generated is associated with the structural image, then the header information from that first DICOM image file is used in the DICOM conversion. Otherwise, default DICOM header variables are assigned. In either case, all dimensions and position header variables are reset on output to match the fused volume. To fuse the native space structural image and a normalized functional `spmT` image, for example, the `wfu_fuse` functions within WFU_DICOMtk compute the transformation between the two images and perform the overlay, maintaining all cross-sectional referencing capabilities and patient identifiers. The fused volume can then be output to an SPM volume or saved as JPG slices. The user may optionally anonymize any or all of the DICOM header variables outlined in ACR/NEMA Supplement 55 before converting the fused volume to DICOM and sending the results to a PACS server.

WFU_DICOMtk can also convert single 2-D images to DICOM format. Default header variables are used, and any color information in the original image is maintained in the resulting DICOM file.

WFU_DICOMtk may be used for viewing a DICOM image and most variables in its header. Private variables and those referencing large arrays, overlays, or palettes are not shown in the variable list.

Getting Started

· *Setting up the PACS server host table*

If running under Linux or Solaris, the CTN send_image binaries are called to send DICOM files to a PACS server. Otherwise, sending to PACS is not supported in WFU_DICOMtk.

On Linux or Solaris, the dicom_host_table.txt file distributed with WFU_DICOMtk should be modified to reference any local PACS systems that will be receiving converted DICOM files. The dicom_host_table.txt file may be edited with any text editor to give the specifics for each PACS server. Alternatively, the entries for each server may be made through the WFU_DICOMtk interface (see Figure 5 below). The table is space delimited with the '#' character in column 1 of any line indicating a comment. The supplied table contains a comment and an example server entry:

| # | node_name | application | aetitle | port | node_ip_number | maxToSend |
|-------|-----------|-------------|---------|------|----------------|-----------|
| Host1 | | FMRI | MRAW | 104 | 127.0.0.1 | 1 |

Lines may be added to the table, one for each additional PACS server to be accessed. Users may need to consult a systems administrator to obtain the information for node_name, application, aetitle, port, and node Internet Protocol number. The maxToSend field refers to the maximum number of files to send to the PACS server at one time and may be limited by command line length.

The send_image command-line syntax is:

```
send_image -a application -c aetitle -r node port filenames
```

where the node argument is the IP number.

· *Running the program*

The program may be started from the SPM drop-down menu or from the command line with:

```
wfu_dicomtk
```

To supply one or more optional arguments:

```
wfu_dicomtk('nopref')  
wfu_dicomtk('contextmenu')  
wfu_dicomtk('noversion')  
wfu_dicomtk('nopref', 'contextmenu')  
wfu_dicomtk('nopref', 'contextmenu', 'noversion')
```

* *nopref* starts the program without loading any preference settings. Without the 'nopref' argument, any existing wfu_dicomtk.mat file in the MATLAB user preferences directory will be loaded. On exit, if the user chooses to save the program settings, then this wfu_dicomtk.mat file will be overwritten if it already exists.

* *contextmenu* allows use of a uicontextmenu instead of the menubar. If running under MATLAB7.5 (or later) without the java GUI, then the context menu will be set by default since this version of MATLAB has no menubar support. A right-click in the WFU_DICOMtk window will cause the context menu, if in use, to appear. In context menu mode, two pushbuttons for **undo preferences** and **exit** are shown on the main GUI panel since the corresponding callbacks contain references to MATLAB's closereq function.

* *noversion* prevents display of the WFU_DICOMtk version number in the window caption.

Figures

Figures 1 and 2 below demonstrate how to run the example data sets. Figures 3-8 below illustrate and explain all of the program options available from the menubar.

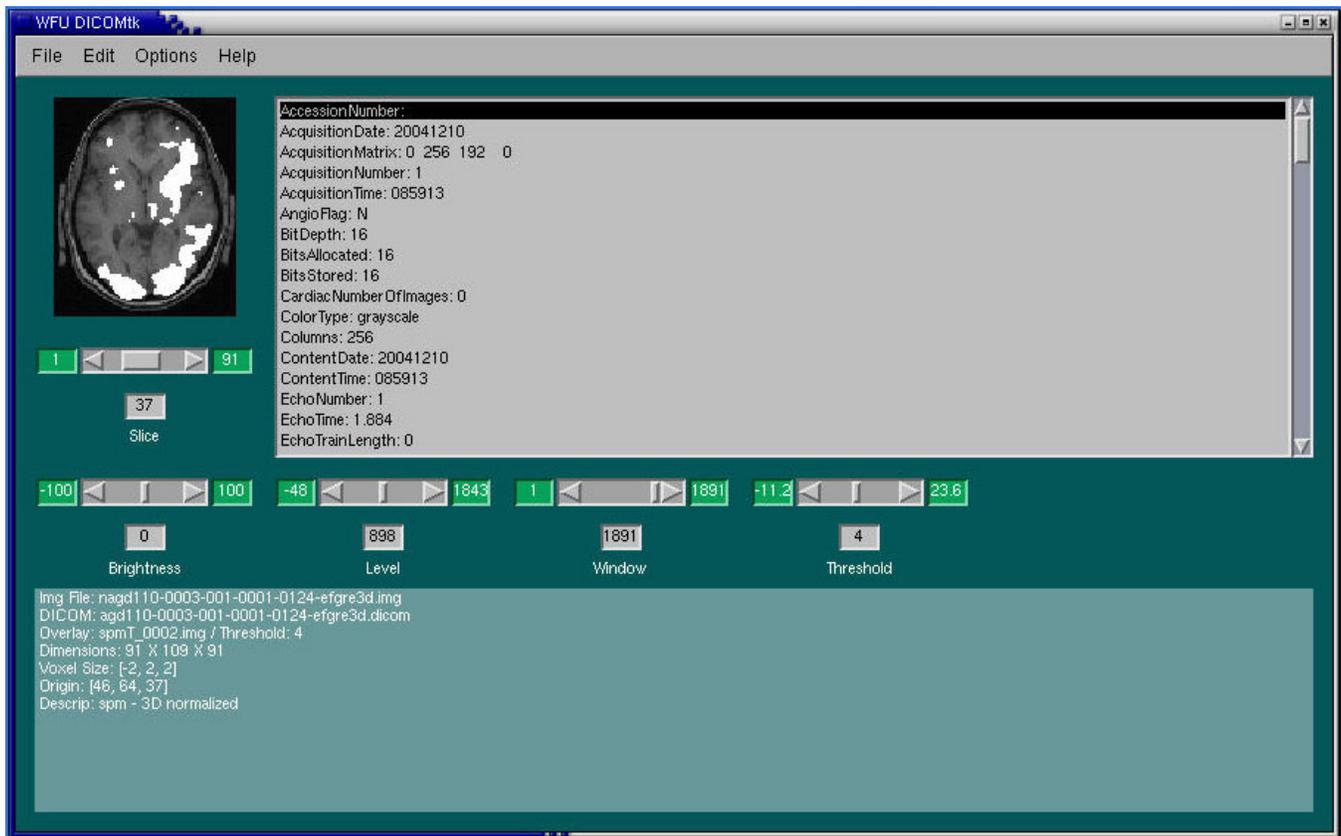


Figure 1: The example fused volume is generated with the following selections:

File/ Open Structural Image:

nagd110-0003-001-0001-0124-efgre3d.img

File/ Associate DICOM Template:

agd110-0003-001-0001-0124-efgre3d.dicom

File/ Add Functional Overlay:

spmT_0002.img

Threshold cutoff:

4

The fused volume is converted to DICOM with:

File/ Convert to DICOM

Dialog Modify header (choose OK after optionally changing these fields):

Series Description: SeriesDescription

Series Number: 93

Study Description: StudyDescription

Dialog Convert now? (choose OK after optionally browsing for new directory):

Write converted files to:

/tmp/todicom?

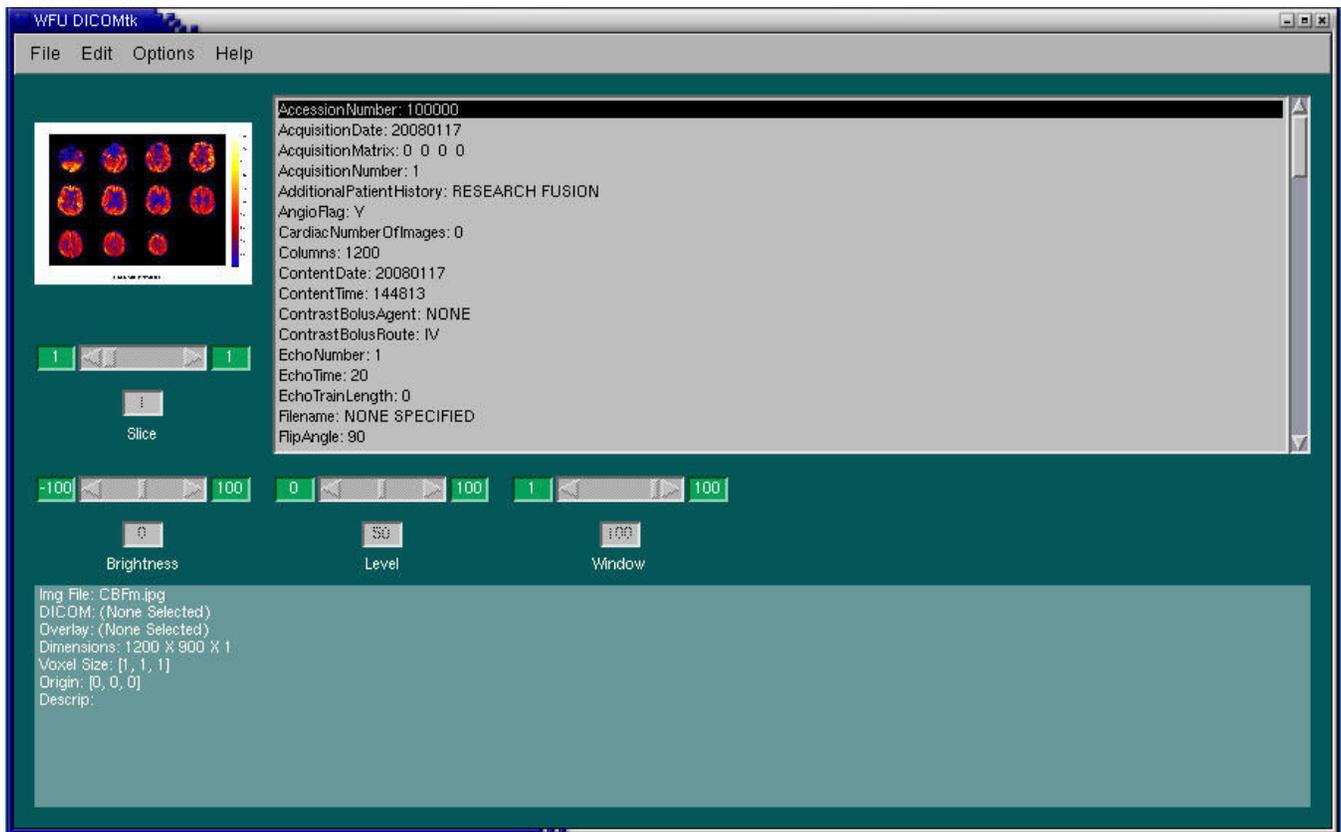


Figure 2: The example JPG image is converted to DICOM with the following selections:

File/ Open Structural Image:

(File filter = Files of type: All files)

CBFm.jpg

File/ Convert to DICOM

Dialog Modify header (choose OK after optionally changing these fields):

Series Description: RESEARCH

Series Number: 93

Study Description: RESEARCH

Dialog Convert now? (choose OK after optionally browsing for new directory):

Write converted files to:

/tmp/todicom?

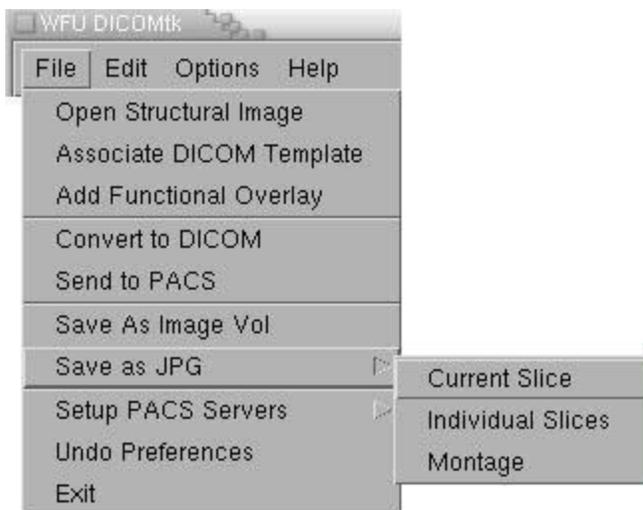


Figure 3: The File menu includes choices to: (a) open a structural image for display; (b) associate a DICOM template with it for optional header viewing or conversion; and (c) add a functional overlay. The structural image may be a 3-D volume that can be read by SPM, any 2-D image type (such as JPG) supported by MATLAB's `imread`, or a DICOM file supported by MATLAB's `dicomread`. The functional overlay is expected to be a 3-D volume.

Any opened image may be converted to DICOM format with the results written into an existing directory or into a newly created location that is based on the image or overlay file name. Once converted, the files may be sent to a PACS server.

The displayed structural image with or without an overlay can be saved as an image volume by SPM. JPG files may be created for the current slice or for all slices. A montage of all slices on a single page may also be written in JPG format.

The *Setup PACS Servers* choice lets the user enter all the specifics necessary to access connected PACS systems (see Figure 4 below). The *Undo Preferences* selection returns all interface defaults to their initial settings. This may be helpful for backing out unwanted color or font choices. The user may exit the program by pressing the File/ *Exit* button or closing the window. Upon exit, the current settings may optionally be saved to the individual user's MATLAB preferences directory in the file `wfu_dicomtk.mat`.

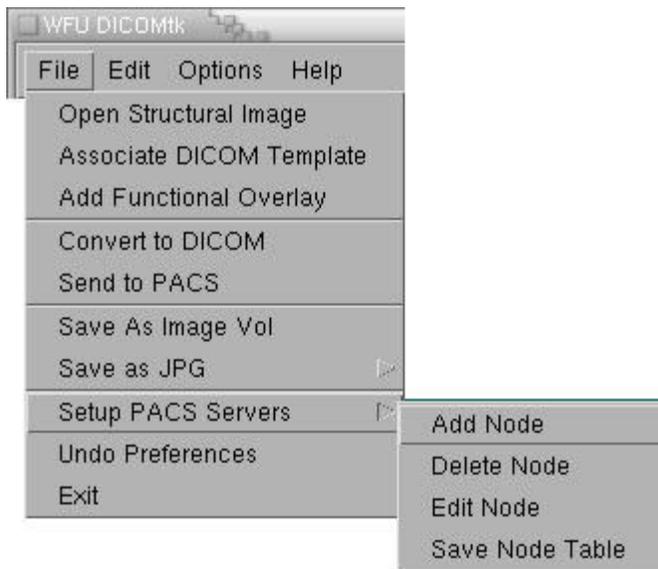


Figure 4: PACS server configurations are stored in the node table file, dicom_host_table.txt. The *Setup PACS Servers* option provides an interface that allows the user to add, delete, or edit nodes and then save the results.

 A screenshot of a dialog box titled 'add a PACS node'. It contains several input fields:

- Node Name: Host1
- Application: FMRI
- AE Title: MRAW
- Port Number: 104
- Internet Protocol (IP) Number: 127.0.0.1
- Max number of files to send at one time: 1
- Active node (0=no, 1=yes): 1

 At the bottom of the dialog are 'OK' and 'Cancel' buttons.

Figure 5: The information stored in the dicom_host_table.txt file contains one line per PACS server. Each line has six fields. When the *Setup PACS Servers Add Node* or *Edit Node* option is selected, the six fields plus an active node indicator as shown in this figure are presented for user entry. All additions and edits may be saved into the dicom_host_table.txt file when the *Setup PACS Servers Save Node Table* option is selected.

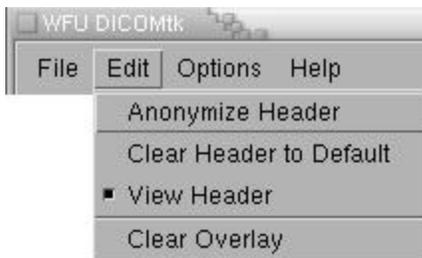


Figure 6: Edit functions

- *Anonymize Header:* In MATLAB7, the `dicomanon` function is called to anonymize selected header variables. In MATLAB6, with no such function, the corresponding header fields are simply set to empty. Any or all of the fields referred to in ACR/NEMA Supplement 55 may be anonymized. The `anonlist6.txt` and `anonlist.txt` files distributed with `WFU_DICOMtk` contain matching DICOM dictionary names for these fields as set by MATLAB6 and MATLAB7, respectively.

- *Clear Header to Default:* Set generic defaults for all header variables.

- *View Header:* Toggle the header variable display on or off. Values displayed from an input DICOM file or a DICOM template associated with the structural image will be those read directly from the DICOM file. Most of these will be saved into any converted DICOM output, but some may be modified by the user. Several fields will be changed on output to match the dimensions of the structural image and the slice position within a volume. When this toggle is on and no DICOM template is specified, generic defaults will be shown instead.

- *Clear Overlay:* Remove any existing overlay from the structural image display.

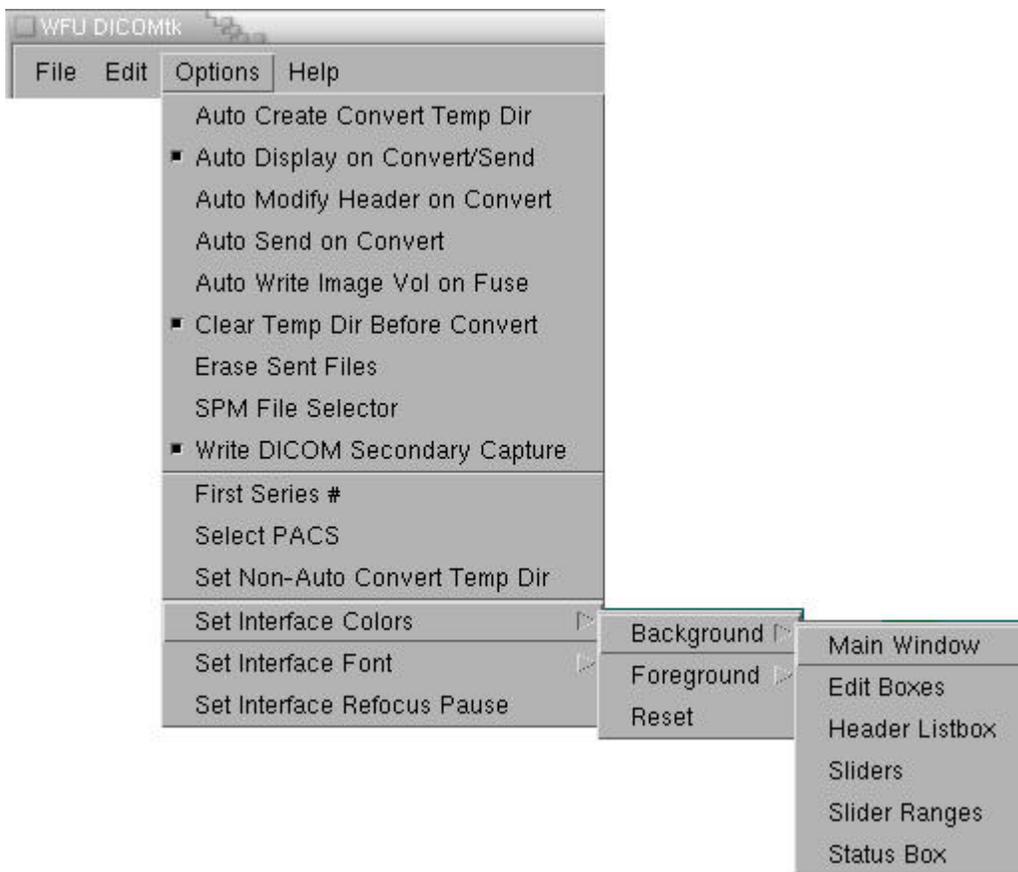


Figure 7: Options

Options/ Toggles

- *Auto Create Convert Temp Dir:* automatically create a temp directory based on input file names; this directory holds the files converted to DICOM; when this toggle is off, converted files go into the directory specified with *Set Non-Auto Convert Temp Dir*.

- *Auto Display on Convert/Send*: automatically display each 2-D image as it is converted and/or sent to PACS.
- *Auto Modify Header on Convert*: automatically set the series # on DICOM conversion with no user prompt.
- *Auto Send on Convert*: automatically send to the selected PACS server(s) after conversion is complete.
- *Auto Write Image Vol on Fuse*: automatically write an image volume whenever fusing a structural overlay.
- *Clear Temp Dir Before Convert*: erase existing files in the temp directory before a new DICOM conversion.
- *Erase Sent Files*: erase DICOM files in the temp directory after they have been sent to PACS without error.
- *SPM File Selector*: use the SPM file selector interface instead of the MATLAB file chooser.
- *Write DICOM Secondary Capture*: write DICOM files as SC (secondary capture) images instead of MR storage. This may be necessary for MATLAB6 output. WFU_DICOMtk always converts non-DICOM, non-volume images such as JPG to SC.

Options/ First Series #: (default is 93) set the series number in the first converted DICOM header; this series # value will be stored in the converted DICOM header, as optionally modified by the user; the # is incremented for each DICOM conversion until a new structural image is opened.

Options/ Select PACS: indicate which PACS servers are to receive files converted to DICOM format.

Options/ Set Non-Auto Convert Temp Dir: define a general purpose location to receive all conversions to DICOM format. When the **Auto Create Convert Temp Dir** toggle is checked, the temporary directory name is based upon the input file names; when off, the non-automatic directory receives the converted DICOM files.

Options/ Set Interface Colors: change individual GUI elements for foreground and background.

Reset will force the specified item to revert to its original color.

Options/ Set Interface Font: modify the GUI font settings (see Figure 8 below).

Options/ Set Interface Refocus Pause: specify the number of seconds to wait before resetting the focus. The value may be zero if no pause is wanted. A nonzero value (such as 0.25) forces the GUI to wait this many seconds before restoring the current graphics window to the topmost position. A nonzero value may be needed on UNIX systems as a workaround for a MATLAB bug that prevents reset of the focus after events such as file name selection. A symptom of this bug is that WFU_DICOMtk gets lost behind other windows on the desktop.

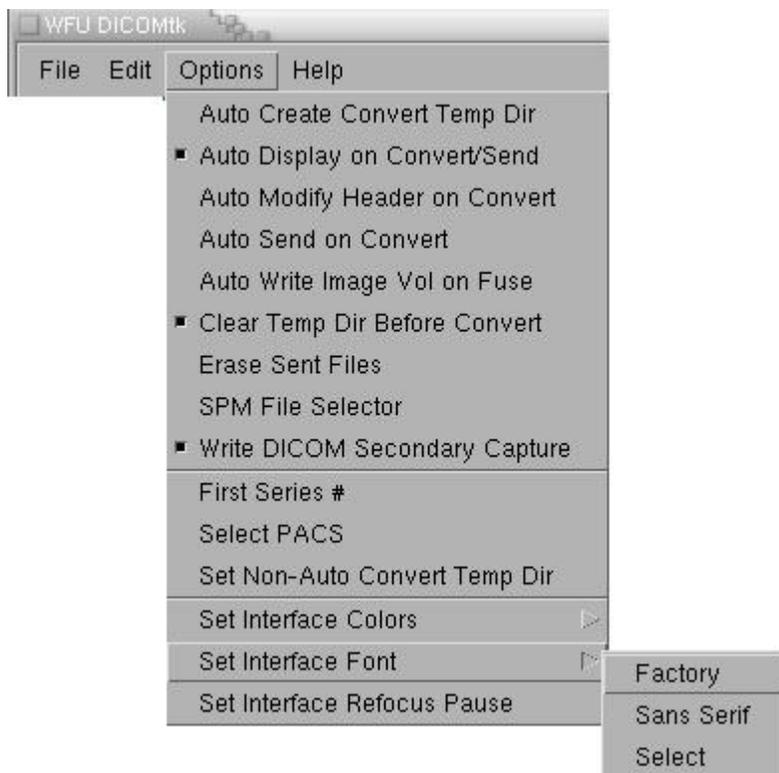


Figure 8: Options/ Set Interface Font

The user may reset the font to the factory setting or to Sans Serif. The Select option gives the user access to available system fonts. MATLAB may or may not render these as expected. When fonts are clipped or appear skewed, setting them to Sans Serif is a workaround for the problem.

Acknowledgements

Thanks to:

- ACR/NEMA for Supplement 55
- CTN for Linux and Solaris send_image binaries
- Chris Wyatt, Ph.D., of Virginia Tech, for image position patient formulae
- Ann M. Peiffer, Ph.D., WFU School of Medicine, for the age deactivation example image
- Robert Kraft, Ph.D., WFU School of Medicine, for the CBF map example image