



User Manual

DICOMscope 1.0

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A. Introduction

The NEMA Committee for the Advancement of DICOM and the European Congress of Radiology (ECR) hosted a demonstration of the proposed DICOM Supplement 33 Grayscale Softcopy Presentation State Storage at the ECR 1999 in Vienna.

The goal of supplement 33 is the improvement of the consistency of image appearance across a network, particularly in order to increase the quality and efficiency of softcopy reading. The proposed DICOM extension allows a workstation or modality to save any grayscale settings, rotation, flip, zoom and annotation and render them in the same way on a different workstation. This extension uses the DICOM Grayscale Standard Display Function to achieve similarity of grayscale contrast on different display devices.

Main part of the demonstration was the DICOMscope software. This manual describes the functionality and features of the DICOMscope software. It will help you learning to use all the functions of this software.

DICOMscope is a full DICOM Viewer with a large variety of functions.

The DICOMscope software is divided into two parts: A study management part simple to use and a viewing component to process DICOM images and presentation states.

This software makes it possible to process and to transmit or receive studies, series, images and presentation states over a TCP/IP network.

DICOMscope supports high-quality systems with special grayscale monitors, special grayscale video cards.

B. Installation and First start

(Microsoft Windows)

DICOMscope requires the Java Runtime Environment (JRE) Release 1.2 or newer (also known as Java 2) and Windows NT. First of all you should install JRE on your system according to the setup instructions provided with JRE. See <http://java.sun.com/> for further details.

Then call the `setup` executable to install the DICOMscope software on your local harddisk. The setup application guides you through the installation process. Do not forget to modify the configuration file (see E.1.).

After a successful installation you can start DICOMscope with a mouse click on the icon or with the start menu from Windows NT.

The DICOMscope application will be loaded and initialized and the study browser will be displayed.

You may click on the tabs on the top of the study browser/viewer to toggle between these components (figure 1).

A status bar gives you some information during the use of DICOMscope.

C. Study management

The study browser (figure 1) shows all studies, series, images and presentation states hierarchically in a tree. From here you can load images or presentation states either from the database or directly from other media like a CD-ROM or a (network) drive. You can also transmit studies, series or single images to other systems. Images can also be deleted.

You will see all the studies loaded from the database in a tree. With a click on the symbols left to the icon you can walk through the hierarchy of studies, series and images / presentation states. The top element of this tree („All Studies“) is always visible, even if no studies are available.

You can load images either with selecting an image and clicking on the „Load“ button or with double-clicking an image entry.

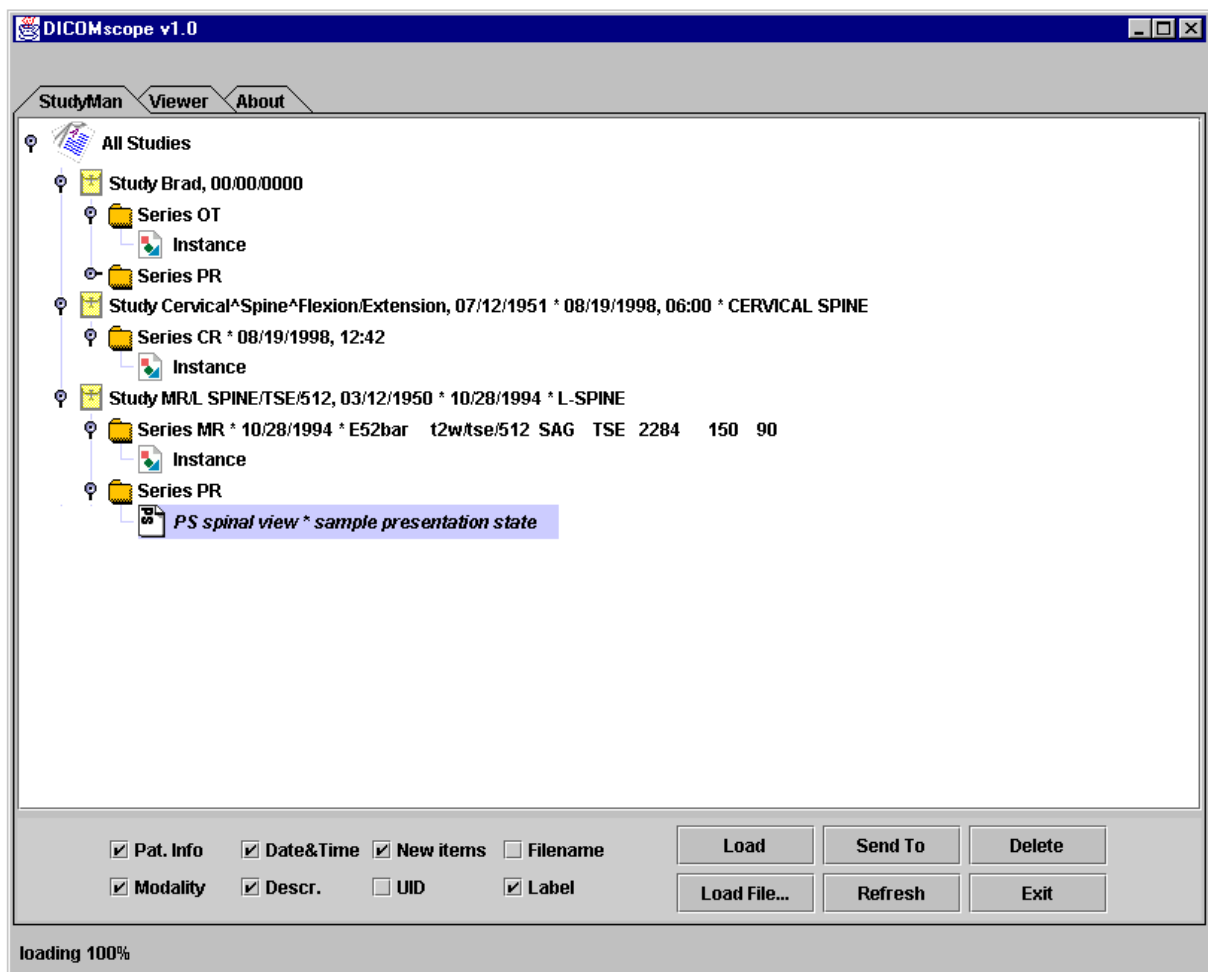


Figure 1 : Study browser

Received images (transmitted over network) are shown immediately in the tree; these images are marked as „new“ / with „new“ icons.

Below the tree you can see six check boxes and six buttons. The check boxes toggle the specified information in the tree on or off:

Pat.Info : toggles patient information on/off (on study layer)

- Modality : toggles modality on/off (on series layer)
- Date&Time : toggles date and time on/off (on study and series layer)
- Descr. : toggles description (on study / instance layer) on/off
- New items : shows new/received studies, series and images with a „new“ icon
- UID : toggles UID on/off (all layers)
- Filename : toggles the filename on/off (on instance layer)
- Label : toggles the label on/off (on instance layer)

The buttons perform the specified function:

- Load** Loads the selected image / presentation state and activates the viewer. If an image is selected and presentation states are available for this image, a list will be shown to select the presentation state (figure 2). You can load the image by selecting the <default> item.

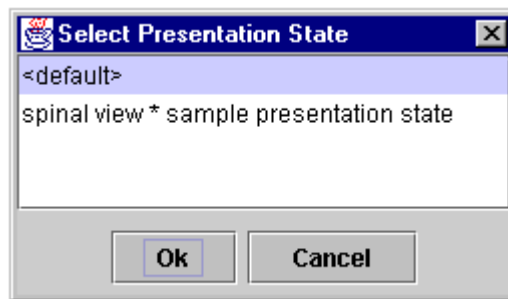


Figure 2 : Select Presentation State Dialogbox

- Load file...** Loads a DICOM file from disk. In the first OpenFileDialog you have to choose a valid DICOM file. In the second OpenFileDialog to may choose a presentation state. If you won't load one you may click the „Cancel“ button. In this case a default presentation state will be used.

Send to Transmits a study, series, image or presentation state to another workstation via network. You can choose the destination from an appearing list or get some information about available destinations (figure 3).

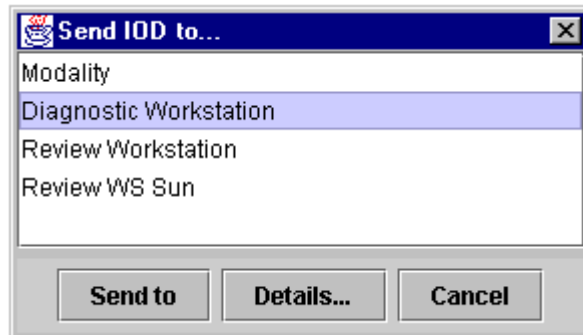


Figure 3 : Send to Dialogbox

Refresh Refreshes the tree and reloads all information from the database.

Delete Deletes studies, series or images. If the top element is selected all studies will be deleted (with an extra confirmation dialog). A confirmation dialog will appear.

Exit Closes the application.

D. Viewer

After loading an image DICOMscope switches to the viewer component. The viewer is divided into three parts (figure 4).

On the right side a function panel offers the main image processing functionality of the software like windowing, zooming, rotating, layer management, shutter management and presentation state management. On the left side the main view visualizes the loaded image with all manipulation. Below the main view a couple of buttons offer the available annotations.

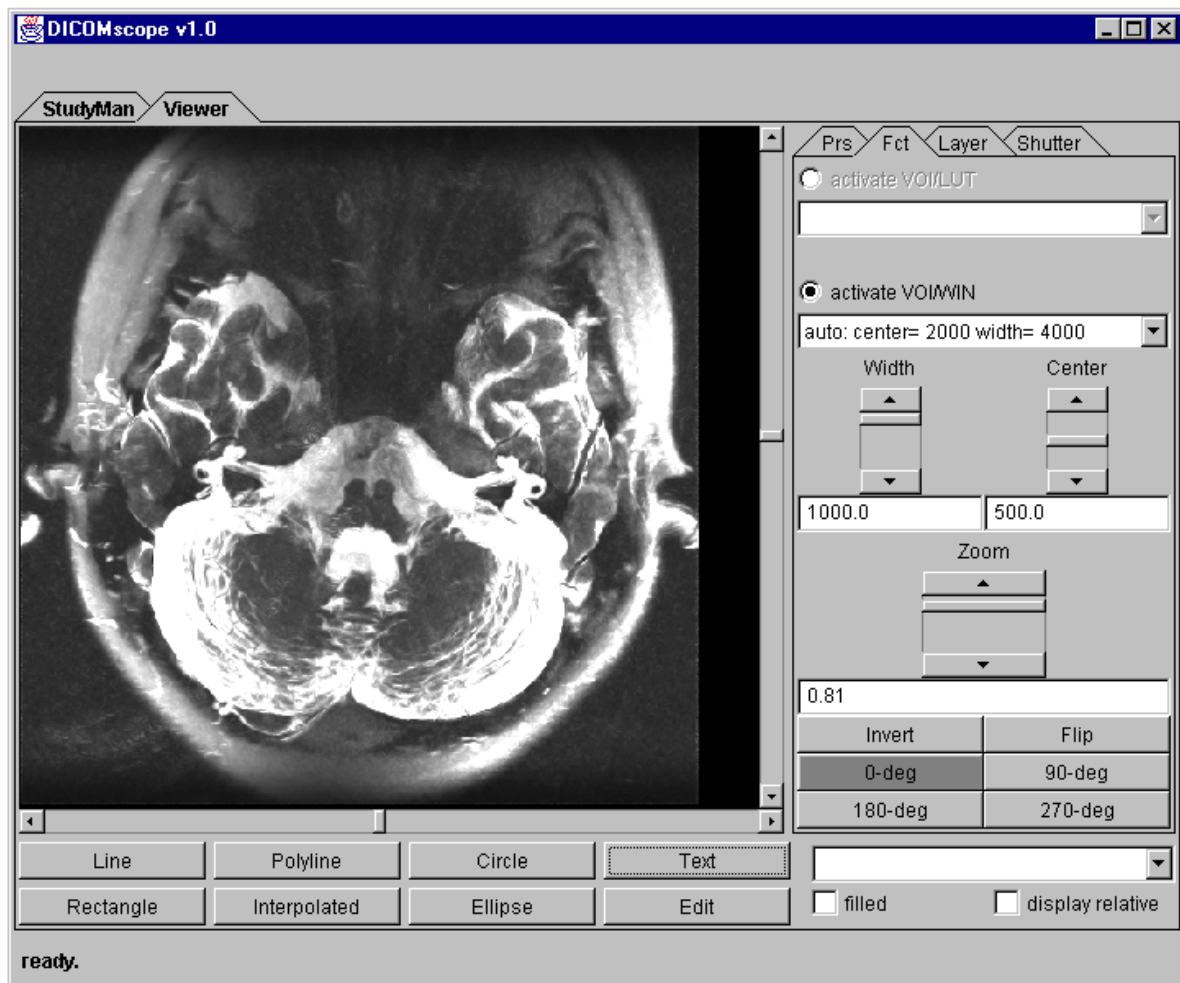


Figure 4 : Viewer

With the scrollbars beside the main view you may scroll the visible (part of) image.

D.1. Presentation states

Presentation state means the current view of the shown image with all annotations, shutters, windows, zoom and so on (figure 5).

On the „Prs“ tab there are six buttons at the top (on a high-quality system only five):

Save

Saves the current image and presentation state with the given label to the database.

Save as file...

Saves the current presentation state and image to disk. In the appearing file dialogbox you have to choose one filename; the dicom image will have the extension „.dcm“, the presentation state will have the extension „.pres“.

Save screen

Saves the current main view content to a secondary capture DICOM file (screenshot).

Reset

Resets the presentation state to the last saved state.

Set Barten on/off

Sets the Barten transform on or off – only on low-quality systems available!

Set PS on/off

Sets the presentation state on or off.

Below these buttons you can modify the ambient light factor to adjust the gamma correction of the display function.

The three fields „Label“, „Creators name“ and „Description“ can be modified to name the presentation state, to show who made it and what description it has. The label and description will be visible in the study browser and in the select dialog when an image with presentation states will be loaded (figure 2).

The „Infos“ field gives you additional information about the presentation state and image.

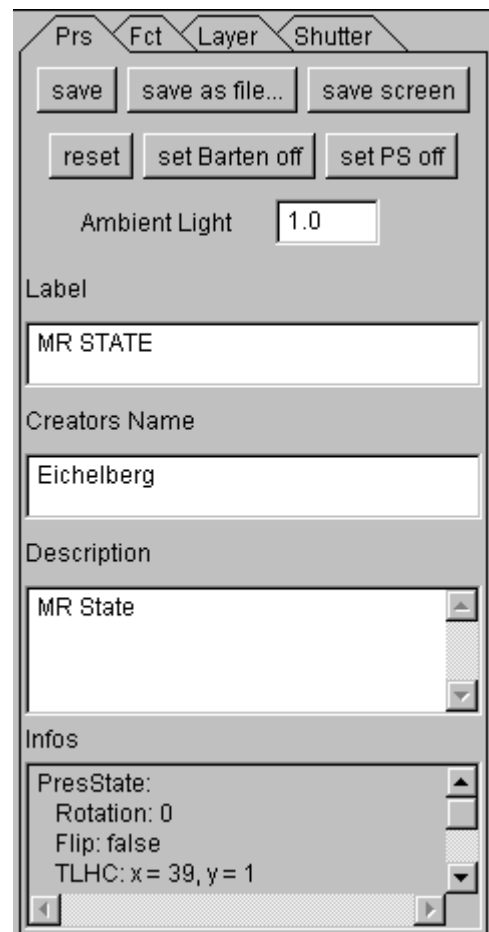


Figure 5 : Presentation state tab

D.2. Image processing

Images or presentation states may contain either VOI LUTs or VOI Windows or both. Per default the first VOI LUT will be selected (see the top combo box in the „Fct“ tab) if a VOI LUT exist.

Other VOI LUTs can be selected in the relating combo box. If there is no VOI LUT the VOI Window is selected. In this case you can select given windows or change a window manually with the two sliders „Width“ and „Center“ or by entering values in the fields below these sliders (figure 6).

The image may be zoomed with the zoom slider or the related number field below the zoom slider. The visible part of the image can be moved with the sliders beside the main view.

Further the image can be inverted, flipped or rotated with the given buttons.

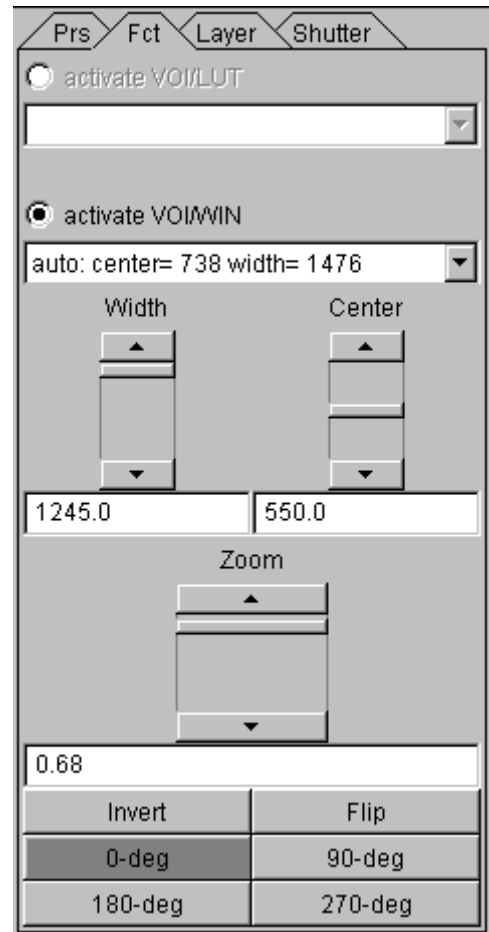


Figure 6 : Function tab

D.3. Layers

Annotations must be ordered in layers. If you click on an annotation button and there is no existing layer you have to create a layer before you create a new annotation.

In the tab panel „layer“ (figure 7) on the right side you see all available layers in the combo box above the description field. Below the description field and three buttons you see a list of all annotations in the selected layer.

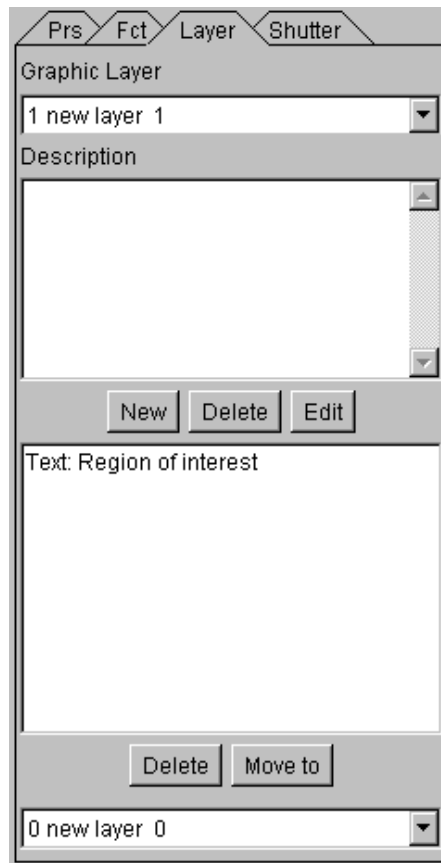


Figure 7 : Layer tab

D.3.1. Create a layer

Layers can be created with the „New“ button in the „Layer“ tab on the right side. If there is no existing layer, the first layer can also be created with a click on an annotation button (below the main view). A dialog box will appear. Here you can type in the properties of the new layer (figure 8).

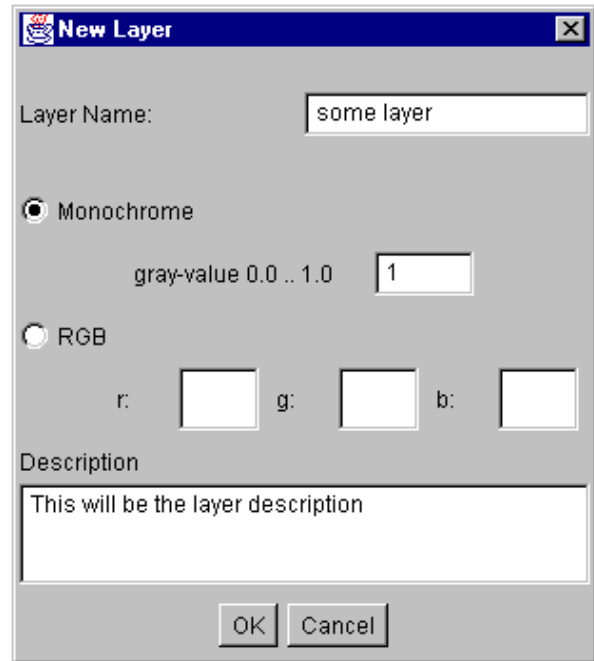
Each layer may have a name, a description and a monochrome gray value. Value 0 means black and goes up to 1 that means white. RGB layers are not supported yet.

D.3.2. Modify a layer

If you wish to change a layers property you have to select the layer with the combo box at the top of the „Layer“ tab. Then you can click on the „Edit“ button to change the properties like name, gray value or description.

D.3.3. Delete a layer

To delete a layer you have to select it first with the combo box at the top of the „Layer“ tab. Then you can click on the „Delete“ button below the description field.



The screenshot shows a dialog box titled "New Layer" with a close button (X) in the top right corner. The dialog contains the following elements:

- Layer Name:** A text input field containing "some layer".
- Monochrome:** A radio button that is selected.
- gray-value 0.0 .. 1.0:** A text input field containing "1".
- RGB:** A radio button that is unselected.
- r:** An empty text input field.
- g:** An empty text input field.
- b:** An empty text input field.
- Description:** A text area containing the text "This will be the layer description".
- Buttons:** "OK" and "Cancel" buttons at the bottom.

Figure 8 : Layer properties

D.4. Annotations

Below the main view eight buttons (figure 9) offer the available annotations or an edit mode. Each of the graphical annotations can be set to „display relative“ and „filled“. Text annotations may have a display relative bounding box or anchor point or have the anchor point visible. And you can decide to have a bounding box, an anchor point or both.

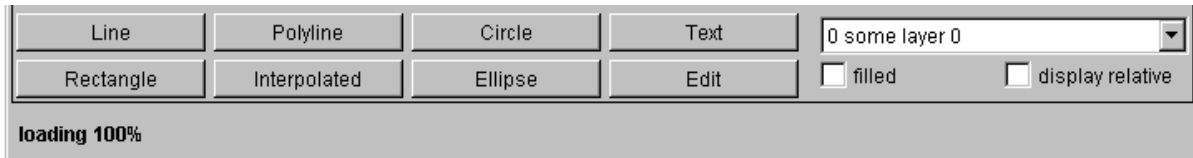


Figure 9 : Annotation buttons

D.2.1. Create a vector annotation

Each annotation must belong to a layer. If you click on one of the annotation buttons and no layer exists you will be asked to create a layer first. The „create layer“ dialog will appear. After you have set the properties of the layer and clicked on the „Ok“ button you can draw the selected annotation in the main view.

If at least one layer exists you won't be asked to create a layer. In this case you can select the destination layer either with the combo box on the top of the „Layer“ tab or with the combo box right to the „Text“ button.

The color of the annotation will be the color of the selected layer.

D.4.1. Modify a vector annotation

You can change the properties of annotations (being filled or display relative). To do that you can click on the „Edit“ button below the main view. The mouse cursor will change in the main view to a hand cursor. Then click on the annotation with the right mouse button. In the appearing context menu you can select or deselect the editable options.

D.4.2. Delete an annotation

To delete an annotation there are two ways. On the one hand you may click on the „Edit“ button below the main view and then right-click on an annotation. In the appearing context menu you may click on „Delete“. On the other hand you can select the annotation in the list on the „Layer“ tab. In this list appears each annotation of the current layer. Perhaps you have to select the correct layer first. To delete an annotation by this way you have to select an annotation in the list and click on the „Delete“ button below this list.

D.4.3. Move an annotation in the main view

To change an annotations position you have to click on the „Edit“ button below the main view. Then right click on the annotation and choose „Move“ in the appearing context menu. After that you can change the annotations position.

D.4.4. Move an annotation to another layer

You can move an annotation to another layer with selecting the current layer and annotation in the „Layer“ tab. Then select the destination layer with the combo box below the „Delete“ and „Move to“ button (figure 10). After that you may click the „Move to“ button to move the selected annotation to the given destination layer.

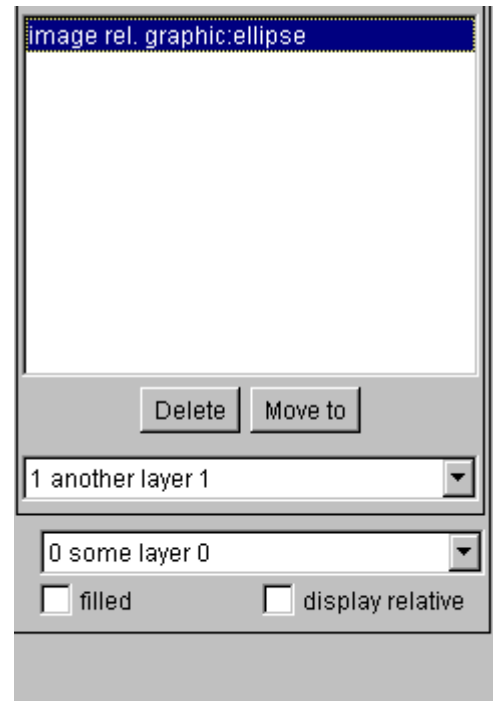


Figure 10 : Move annotation to another layer

D.4.5. Text annotations

If you click on the „Text“ button a dialog box will appear (figure 11). You can type in the text, choose if there should be a bounding box, an anchor point or both and whether the bounding box or the anchor point should be display or image relative. If you choose „anchor point visible“ (default) a line will connect the anchor point and an edge of the bounding box.

You may change the properties of text annotations in the same way as vector annotations.

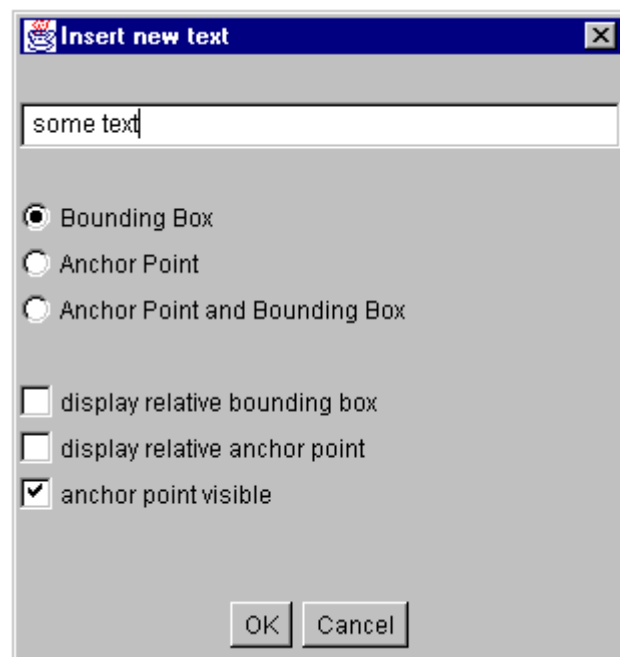


Figure 11 : Properties of a text annotation

D.5. Shutter

You can use shutters to hide unwanted parts of the shown image. Supported are vector shutters like rectangle, polygon and circle and bitmap shutters (see figure 12). Bitmap shutter creation is not supported in this software. If more than one bitmap shutter is available you may select one of them or none. Each type of shutter may appear only once in a presentation state.

Existing shutters are marked with a hook. Shutters may intersect other shutter types.

The gray value around the shutter area can be changed from 0 (means black) up to 1 (means white).

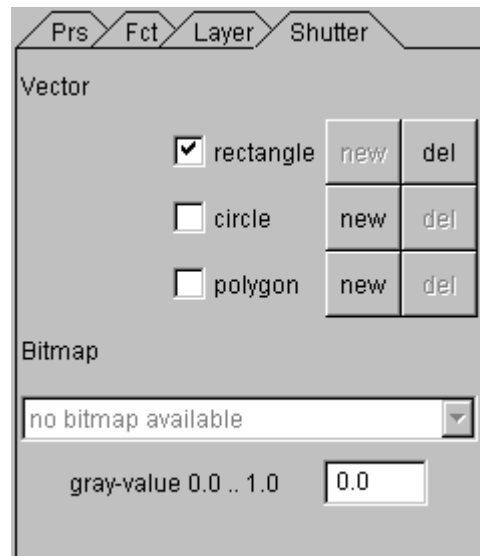


Figure 12 : Shutter tab

D.5.1. Create a vector shutter

To create a vector shutter click on a „New“ button in the „Shutter“ tab. After that draw the shutter in the main view. You can finish the drawing of polylines and interpolated with a right mouse click and a menu selection (stop / close).

D.5.2. Delete a shutter

To delete a vector shutter click on a „Del“ button in the „Shutter“ tab.

To delete a bitmap shutter change the selection in the bitmap shutter combo box.

E. Configuration

E.1. Configuration file

All information DICOMscope needs to run proper on different systems and in different environments is stored in a single configuration file (DICOMscope.cfg). This text file is read only once during the application start-up process, i.e. if you have modified anything you need to restart the application.

The configuration file consists of entries which have the form

```
keyword = value
```

It is important that the keyword begins in the first column of a newline. Keywords are not case sensitive, but values are. Entries in the configuration file are grouped in a section, which is identified by a keyword in square brackets:

```
[section]
```

Multiple sections are grouped into a main section, which is identified by a keyword in double square brackets:

```
[[main_section]]
```

The first part of the configuration file for DICOMscope is identified by the main section heading `[[GENERAL]]`. This part defines the settings of the local system, e.g. database directory and local network characteristics. The following table describes the defined sections and entries:

Section	Keyword	Value	Description
Monitor	Characteristics	filename	Name of the monitor characteristics file. If omitted, no grayscale correction according to DICOM Part 14 is performed.
Database	Directory	directory	Directory in which the image database resides
Network	Sender	executable	Path to the DICOM sender (Store SCU) application to be used. Should never be changed.
	Receiver	executable	Path to the DICOM receiver (Store SCP) application to be used. Should never be changed
	Port	1..65535	IP Port number on which the receiver listens for new connections. On Unix platforms, the receiver must be started with setuid root if port numbers < 1024 (i.e. the standard DICOM port number 104) should be used.
	MaxPDU	8192..65536	Maximum PDU (protocol data unit) size to use when negotiating incoming connections. Default is 16384.
	AETitle	string	Application entity title with which both sender and receiver will identify themselves. Max 16 uppercase characters.
	ImplicitOnly	true or false	Only negotiate Implicit VR Little Endian transfer syntax on incoming connections. This is useful only for some old and buggy DICOM Store SCUs (i.e. modalities).
	DisableNewVRs	true or false	Do not create data types (VRs) that were defined in post-1993 editions of the DICOM standard when converting implicit VR network data to explicit VR files.
	BitPreservingMode	true or false	Receive data in "bit preserving mode". In this mode, data is stored to file directly as read from network. Transfer syntax

			in file is identical to transfer syntax used for network transmission. If this mode is switched off (default), images are converted to explicit VR Little Endian format before storing in file, which makes it easier to burn images on CD-R in "General Purpose Image Exchange Profile" format.
GUI	HighEndSystem	true or false	On a „high-end“ system, grayscale correction according to DICOM part 14 is switched off, and the GUI is rendered with much larger fonts. This feature is intended for display systems with a typical resolution of 2x2k and hardware calibration.
	UseRGB	true or false	Defines whether graphical annotations are rendered in grayscale or color. Color should be switched off for this release, since it may affect display speed significantly.

The second part of the configuration file for DICOMscope is identified by the main section heading `[[COMMUNICATION]]`. This part defines the communication partners to which DICOM images and presentation states can be sent from within the Browser. For each communication partner, one section needs to be defined (i.e. `[PEER_1]`.) The section heading is arbitrary but must be unique within the configuration file. It may only contain uppercase characters, numbers and underscore characters. The following table describes the entries for each communication partner:

Keyword	Value	Description
Hostname	string	Hostname, IP number or domain name in conventional TCP/IP notation
Description	string	Description of the communication partner. Used in the GUI to present the send targets to the application user.
Port	1..65535	IP port number under which the communication partner receives DICOM associations
MaxPDU	8192..65536	Maximum receive PDU (protocol data unit) size to use. Must be between 8192 and 65536. Default is 16384.
AETitle	string	Application entity title of the communication partner (in DICOM lingo: Called application entity title). Max 16 uppercase characters.
ImplicitOnly	true or false	Only negotiate Implicit VR Little Endian transfer syntax. This is useful only for some old and buggy DICOM Store SCPs.
DisableNewVRs	true or false	Do not create data types (VRs) that were defined in post-1993 editions of the DICOM standard when converting implicit VR files to explicit VR network transmission. Maybe necessary for old DICOM Store SCPs.

E.2. Monitor characteristics file

To perform the Barten transform you need a text file describing the characteristic curve of your display device (monitor). This file can be created automatically by using a calibration tool like VeriLUM and converting its output to a more common format which can be read by DICOMscope¹. You can also try to adapt the sample file (`monitor.lut`) which is part of this distribution manually by editing the luminance values for each DDL (device driving level).

¹ This conversion can be done by the console application `dconvlum` from the DCMTK (see `dcmtk/dcmimgle/docs/dconvlum.txt` for further details).

F. System requirements

Low Cost System:

PC with Pentium 200 MHz (Pentium II, 266 MHz recommended)
Microsoft Windows NT 4.0 (and above)
Java 2 Runtime Environment (also known as JRE 1.2) / Sun Microsystems
64 MB memory (128 MB recommended)
TCP/IP network recommended

High-Quality-System:

PC with Pentium II, 333 MHz or above
Microsoft Windows NT 4.0 (and above)
Java 2 Runtime Environment (also known as JRE 1.2) / Sun Microsystems
256 MB memory
DOME Md5/PCI video board
A DOME video board compliant monitor
TCP/IP network recommended

Disc space :

21 MB for Java Runtime Environment
4 MB for DICOMscope (without images)

G. About the Project

The Project team for the implementation consists of:

OTech Inc.: Main contractor and project management
Lake Griffin Ltd.: Project management and hardware coordination
Kuratorium OFFIS e.V.: DICOM toolkit DCMTK (C++)
Institute for Microtherapy; University of Witten/Herdecke: User interface (Java)

This software will be available in the public domain at:

<http://www.microtherapy.de/go/dicomscope/>
<http://www.offis.uni-oldenburg.de/projekte/dicom/>

The draft DICOM standard is available at:

<http://www.nema.org/>

Information can be provided by the industry managers at Nema:

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General Electric Company
Imation / CEMAX-ICON
ISG technologies
Philips Medical Systems
Siemens AG

Hardware was provided by:

Siemens: high resolution monitors
Dome: video boards
Image Smiths: calibration hardware and software for review station

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