MaZda 4.5 Tutorials
3D Image Analysis

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3D data analysis in MaZda

MaZda software is capable of 3D data analysis. It loads 3D data form:

- image file series, where each file stores single cross-section of 3D volume
- a single file that stores complete 3D information

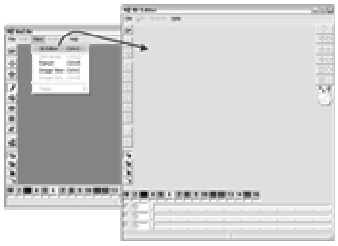
The **3D Editor** of **MaZda** lets the user define three-dimensional regions of interest (ROI). The **3D Editor** provides tools for:

- placing volumes of predefined shape within 3D space of image data,
- resizing them,
- stretching along selected direction and
- rotating
- segmentation of 3D image with an elastic surface model.

MaZda computes a number of textural features within selected 3D regions of interest. The resulting feature lists (or feature vectors) are presented within the Report window.

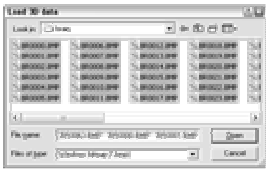
Switching to the 3D analysis mode

After ***MaZda*** is started it usually shows a window for 2D-image manipulation. To switch to 3D image mode, select ***View→3D Editor*** menu option or press [***Ctrl***]+[***3***] from a keyboard. The ***3D Editor*** window will appear. Through the ***3D Editor*** window the tools for 3D data loading, ROI editing and 3D volumes analysis are available.



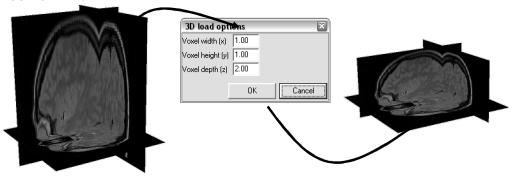
Loading 3D data

To load 3D image data into the ***3D Editor*** select ***File→Load image...*** from ***3D Editor*** menu, press [***Ctrl***]+[***L***] from a keyboard or press ***Load image*** tool button.
The ***Load 3D data*** dialog window appears to choose input file type and to select file or files to be loaded.
To load several image files (all the files must be stored in a single folder), select a group of files by a typical Explorer's ***Shift+Ctrl+Mouse*** method, and then press ***Open*** button.



Setting proportions

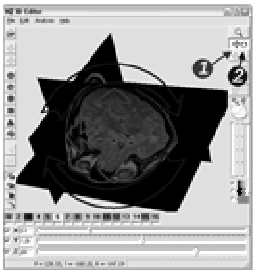
The image may be presented with wrong proportions. The cause of this appearance is a way the image is produced by a medical scanner. Three-dimensional volume is scanned over several parallel cross-sections. The distance between cross-sections is usually different from a distance between adjacent pixels within a cross-section. To set appropriate proportions of presented image, adjust these proportions with ***3D load options*** dialog box (***File→Image options...*** from ***3D Editor*** menu) and set a voxel proportions appropriately.



Adjusting the 3D data view

The view angle can be adjusted after selecting **Turn all** tool.

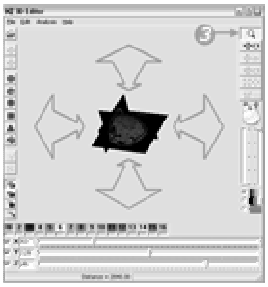
- To adjust pitch or yaw angles press the left mouse button and slide the mouse cursor across the **3D Editor** window.
- To adjust roll angle press the right mouse button and move the mouse cursor horizontally across the window.



Adjusting the 3D data view

The viewed data can be zoomed in or out (or rather pulled toward or pushed outward) by means of ***Push or pull all*** tool.

To do this select the ***Push or pull all*** tool and then, while pressing the left mouse button, move the mouse cursor vertically across the ***3D Editor*** window.



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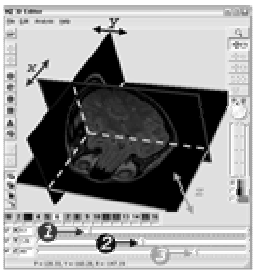
Adjusting the 3D data view

The data is viewed in a form of thee perpendicular cross-sections. Some of these cross-sections may be excluded from viewing by un-checking the **X**, **Y** or **Z** check box.

The location of cross-section can be adjusted by one of three slide-bars located at the lower part of ***3D Editor*** window.



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Adjusting the 3D data view

The gray-scale window limits on the brightness scale can be adjusted by setting the position of two slide-bars located vertically on the RHS of the window. These adjustment tools are useful for correcting the image contrast or overall brightness of presented data.

Below the slide-bars there are three radio buttons. Choosing the middle one will cause the image to be displayed in three gray-levels. The slide-bars in this mode serve as gray-level threshold selectors. Choosing the lower radio button will cause the data to disappear. The viewed cross-sections are uniformly gray (if no ROI is defined). These two modes of image presentation are useful when editing regions of interest with a ***Flood fill*** tool.

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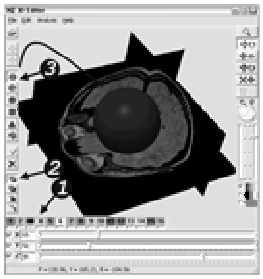
Editing regions of interest

To edit regions of interest for the textural analysis:

1. Select the color (number) of region to be created form the palette
2. Select the "drawing" mode: non-overlapping ROI, overlapping ROI or modes for erasing fragments of already existing regions
3. Select one of predefined blocks (sphere, tube, cube or tetrahedron)
4. Adjust the block location, orientation, size and shape
5. Press Accept button to merge the resulting block with a ROI of selected color



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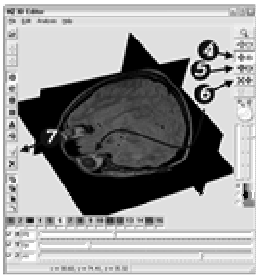
3. Select one of predefined blocks (sphere, tube, cube or tetrahedron)

4-6. Adjust the block location, orientation, size and shape

7. Press *Accept* button to merge the resulting block with a ROI of selected color



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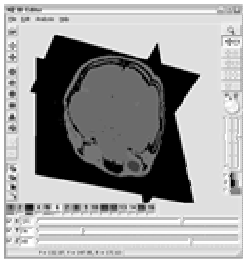
Switching regions on and off

The created regions are visible in a form of color highlights.

Sometimes it is useful to temporary hide this highlights. The user can switch the ROI on and off from viewing by clicking tiny bars located just below color (ROI number) selection buttons. These tiny bars have also informative function. They are colored if the corresponding region exists and grayed otherwise.



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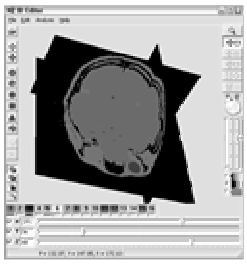
Flood-filling the volume

The ROI may be also created by means of flood-filling tool. To get the volume flood-filled, it is convenient to switch the image to three gray-level presentation mode and set up the gray-level scale thresholds to distinguish the volume to be filled-in. Next step is to select the **Flood-fill** too, point with a mouse cursor at the volume.



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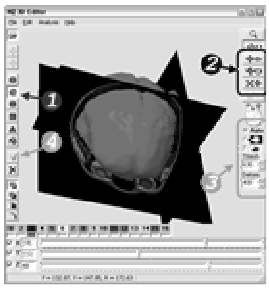
Elastic surface model

An elastic surface is a mathematical model of enclosed surface that deforms upon some local characteristics of 3D image. The final shape of the model depends on initial shape, location of the surface and model's parameters. In **MaZda**'s ***3D Editor*** the model of center point deformable surface has been implemented for ROI editing.

To edit ROI with elastic surface:
1. Select ***Create spherical-elastic ROI*** tool
2. Adjust position and size of a model
3. If needed, switch off automatic mode and adjust ***Thresh.*** and ***Deform.*** parameters
4. Press the ***Accept*** button



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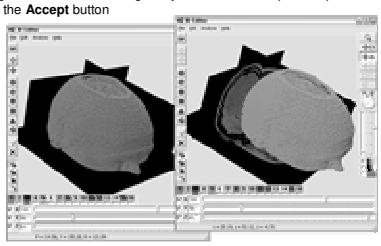
Moving and copying regions

Any existing region can be moved or copied. To move or copy the region:
1. Select, from a palette toolbox, a color (number) of a region to be moved or copied.
2. Select a **Move** or **Copy** button
   (after a while a three-dimensional model of selected region will appear)
3. Change the location of the region by means of move, push or pull tools and a mouse.
4. Press the **Accept** button



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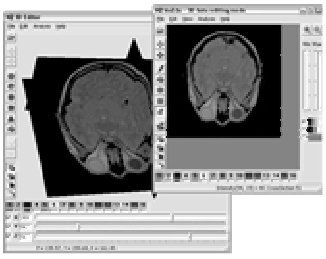
Editing 3D ROI in 2D

The region of interest can be edited cross-section by cross-section. To edit a selected ***Zth*** cross-section, just switch to the main **MaZda** window, edit ROI by means of 2D editing tools and switch back to ***3D Editor*** window. The selected cross-section will be updated.



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Analysis of 3D data

MaZda computes textural features within selected 3D regions of interest. To select options of the computation process select ***Analysis→Options...*** from the ***3D Editor*** menu.

The image can be analyzed as is or may be normalized before textural features computation. There are two types of 3D image analysis implemented in the current version of **MaZda**, based on image histogram computation and on co-occurrence matrix.

Analysis of the 3D data within the defined regions of interest starts after selecting the ***Analysis→Run 3D analysis...*** from the ***3D Editor*** menu. The results of the analysis are presented in the ***Report*** window.

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Exercise 1

1. Start MaZda and switch it to a 3D Editor
2. Load MRI cross-sections of a head (*BR0000.BMP - BR0063.BMP*) from *Tutorials\9_3D_Analysis* folder
3. Define regions covering eye bolls with *Create elypsoidal ROI* tool
4. Define region covering a cerebrum with elastic surface tool (if needed use the elastic surface model several times to fill in a whole volume of cerebrum)
5. Set analysis options of your choice
6. Start the analysis of 3D data
7. What is a volume of cerebrum in voxels?

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Exercise 2

1. Start MaZda or, if it is already started, close all the report tab-pages
2. Switch it to a 3D Editor
3. Load *tex3d1.bmf* file
4. Define 16 cubic regions of interest of an approximate size 30x30x30 voxels
   (the regions may overlap)
5. Set analysis options and run the 3D analysis
6. Set class names of feature vectors to *Texture1*
7. Load *tex3d2.bmf* file and run the 3D analysis
8. Set class names of just generated feature vectors to *Texture2*
9. Select the most discriminative features and reduce feature vector size with methods implemented in MaZda and B11

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