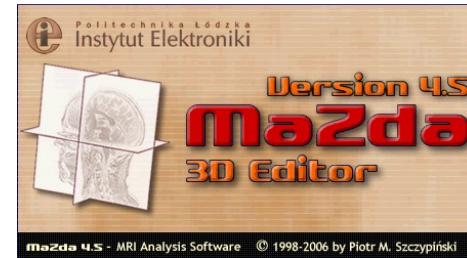


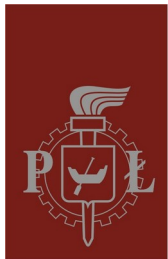
# *MaZda 4.5 Tutorials*

## MaZda Setup



June 2006

Piotr M. Szczypiński



Technical University of Lodz  
Institute of Electronics

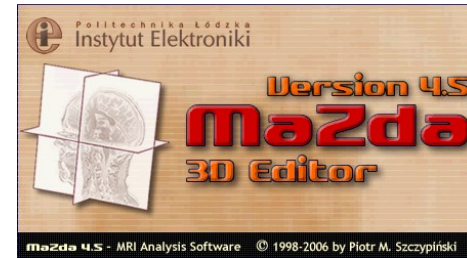
# What is MaZda

1. MaZda is a tool for computation of textural image features in 2D and 3D images
2. It requires:
  1. Microsoft Windows system (98, 2K, XP)
  2. Fast processor  
(some implemented methods are time demanding)
  3. Lots of memory  
(the bigger the image analyzed the bigger memory is needed)
3. Name MaZda is an acronym of „Macierz Zdarzeń”, which in Polish means Co-occurrence matrix

# Setting up MaZda

1. Insert the „MaZda 4.5 & Tutorials” CD into CD drive of you computer
2. Copy the „MaZda” folder into the hard drive of your computer  
(e.g. onto the C: hard drive)
3. Start MaZda by double-clicking on its icon or a filename (The MaZda.exe file is within a MaZda folder)
4. When first started MaZda will register file formats it uses on the system, so they will be assigned an „MZ” icon

# *MaZda 4.5 Tutorials* Grey-scale Image Analysis



June 2006

Piotr M. Szczypiński



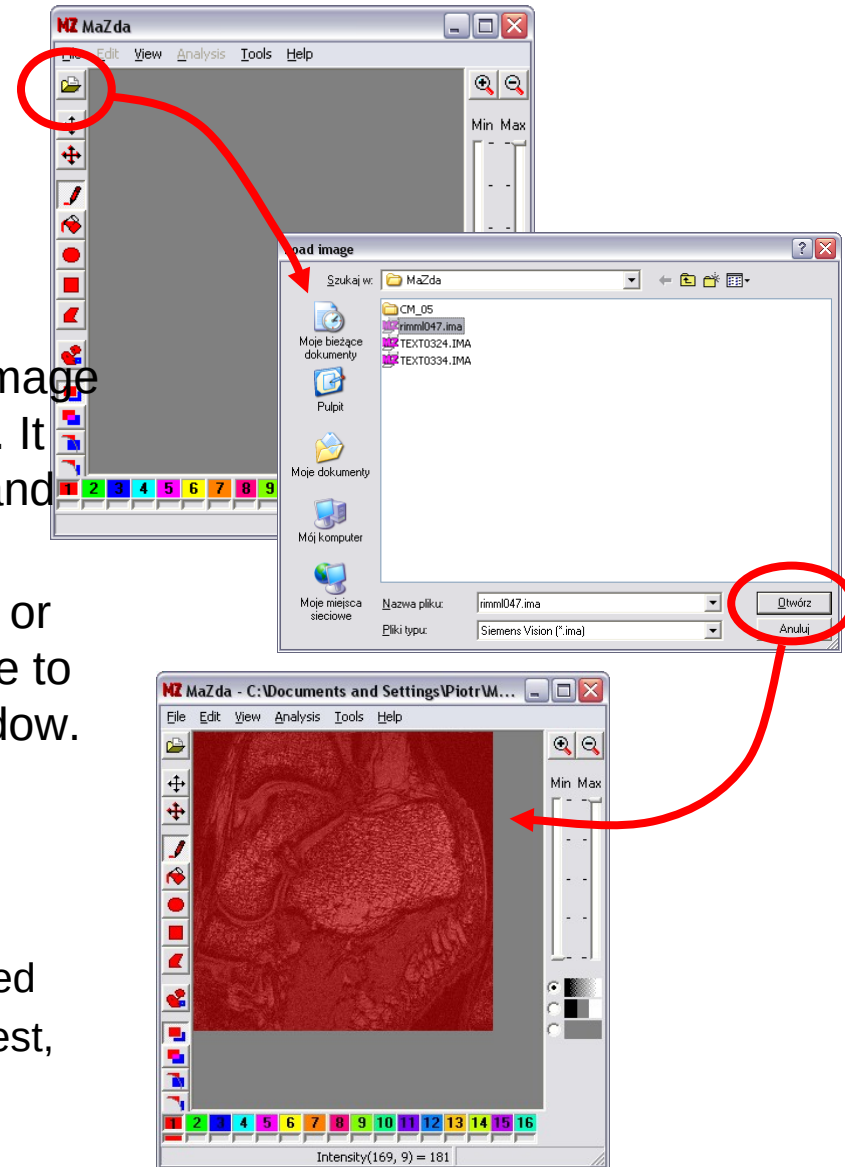
Technical University of Lodz  
Institute of Electronics

# Loading image

There are several ways to load image into the MaZda program:

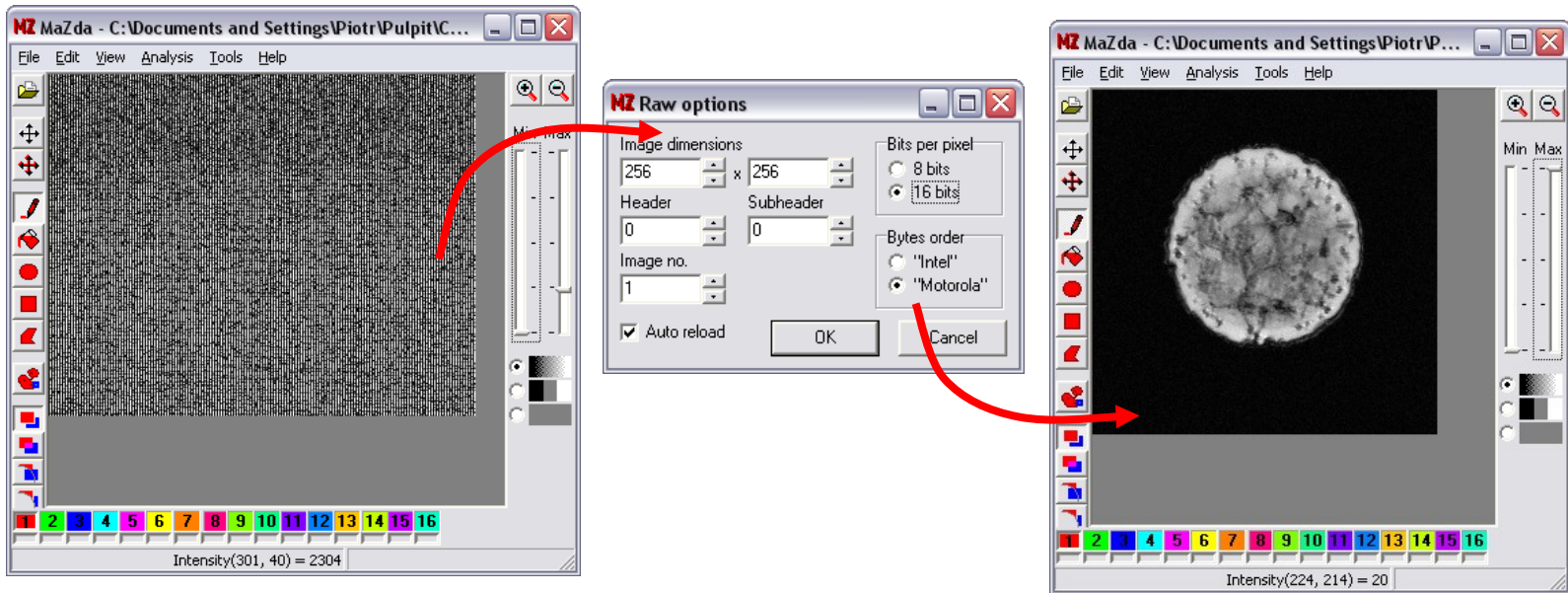
1. Open Explorer and double-click on the image file icon which is associated with MaZda. It will automatically start MaZda program and load the selected image.
2. Start MaZda, select *File* → *Load image...* or click *Load image* button, then select a file to be loaded with a *Load image* dialog window.
3. Drag-and-drop image file from Windows Explorer into the MaZda window

By default the image after being loaded will be colored with red. Colors are used to indicate regions of interest, which will be covered later during this presentation



# Loading RAW images

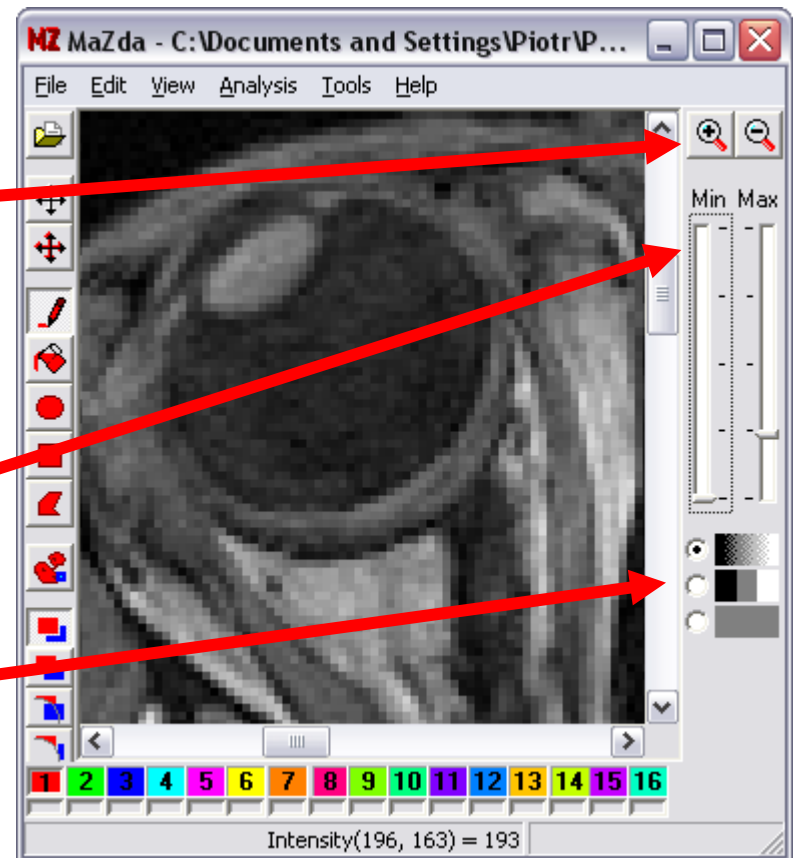
MaZda is capable of loading images without headers or formatting information, called raw images. In case of loading raw image the user must provide additional information to correctly present the image. To set raw image formatting parameters, select *File* → *Raw options...* from the menu and use the *Raw options* dialog box.



Hint: if the image formatting is unknown, check *Auto reload* and observe image while adjusting image parameters

# Viewing image

- To zoom image use *zoom-in/zoom-out* buttons or select View → Zoom option from the menu
- To set image grey-scale window or to adjust brightness and contrast, use *Min/Max* sliders.
- To view thresholded image or to switch the image view off, use the radio buttons located below the sliders.



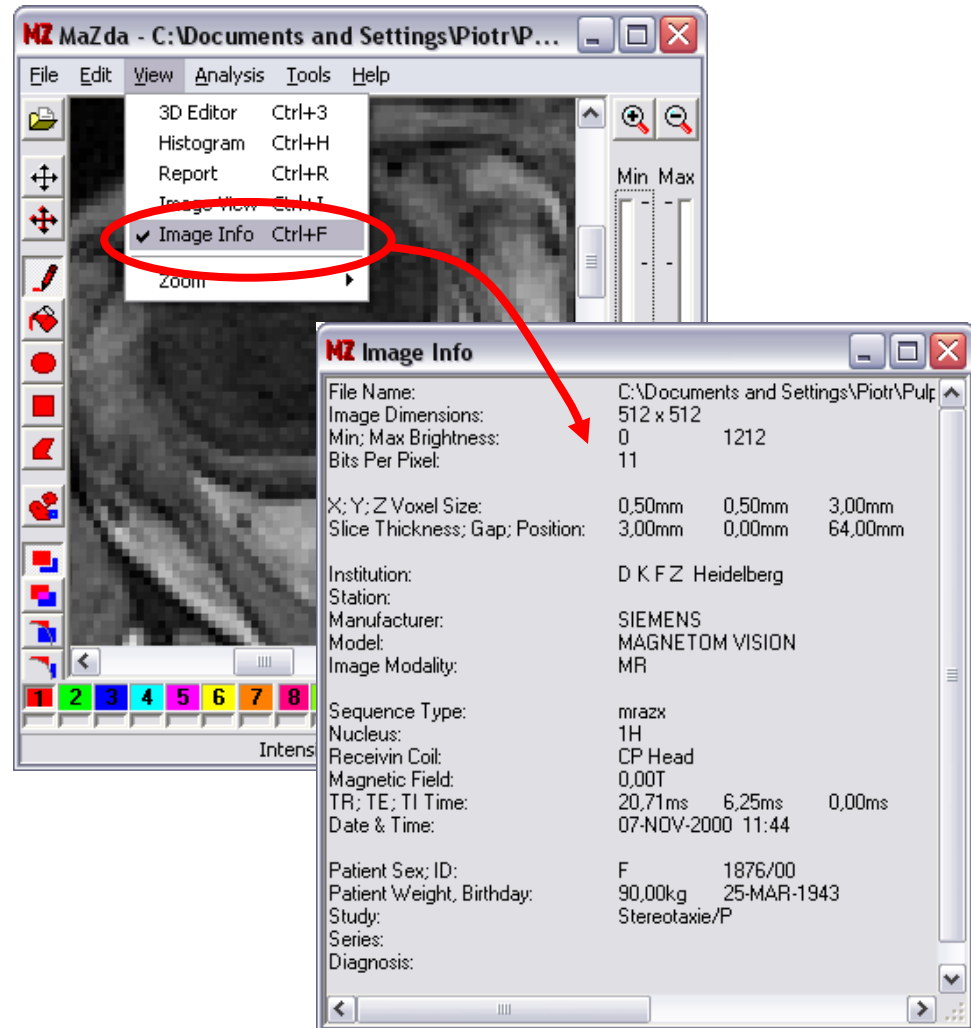
Remark: Adjusting the image view options described here will not affect the image analysis procedure.

# Viewing image information

To view information on the loaded image select

*View* → *Image info...*

from the menu

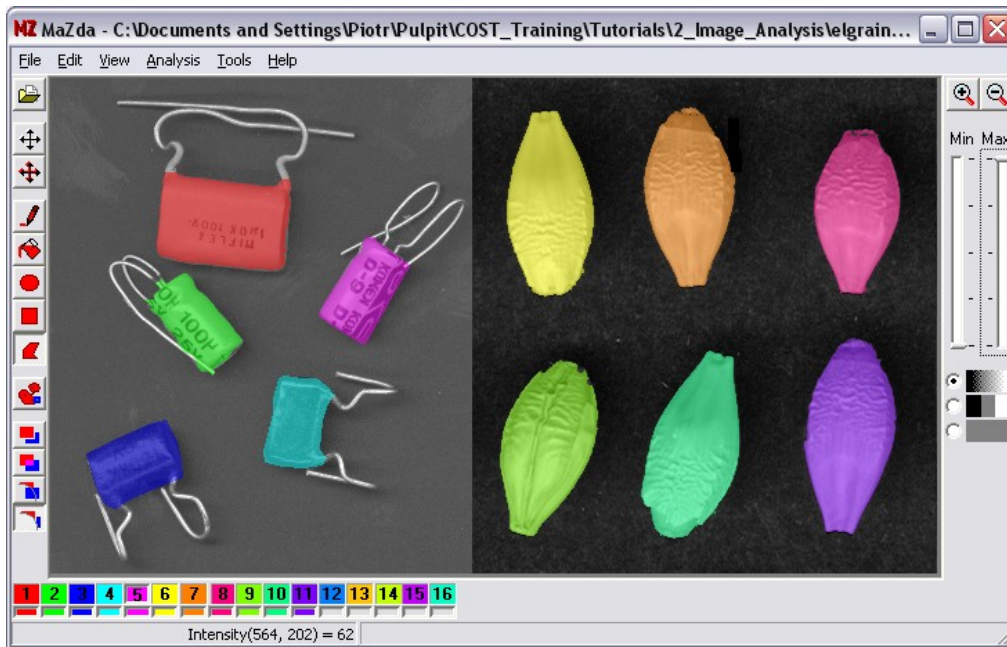




# Regions of interest

MaZda computes numerical values (textural features), which characterize an image or an image fragment (region of interest or ROI). To compute features within a ROI the shape of such ROI must be defined.

Since MaZda works with grey-scale images, the ROI is indicated with a color superimposed on the grey-scale image. Up to 16 ROI shapes may be defined with use of 16 unique colors. These shapes may overlap if needed.



Example of an image presenting 11 separate objects, each object marked with unique color, which indicate they are separate ROIs

# ROI editing tools

## Drawing tools:

- draw line (right-click for width changing)
- fill-in
- draw ellipse or circle (while *Ctrl* pressed)
- draw rectangle or square (*Ctrl*)
- draw polygon

## Morphology transformation tools

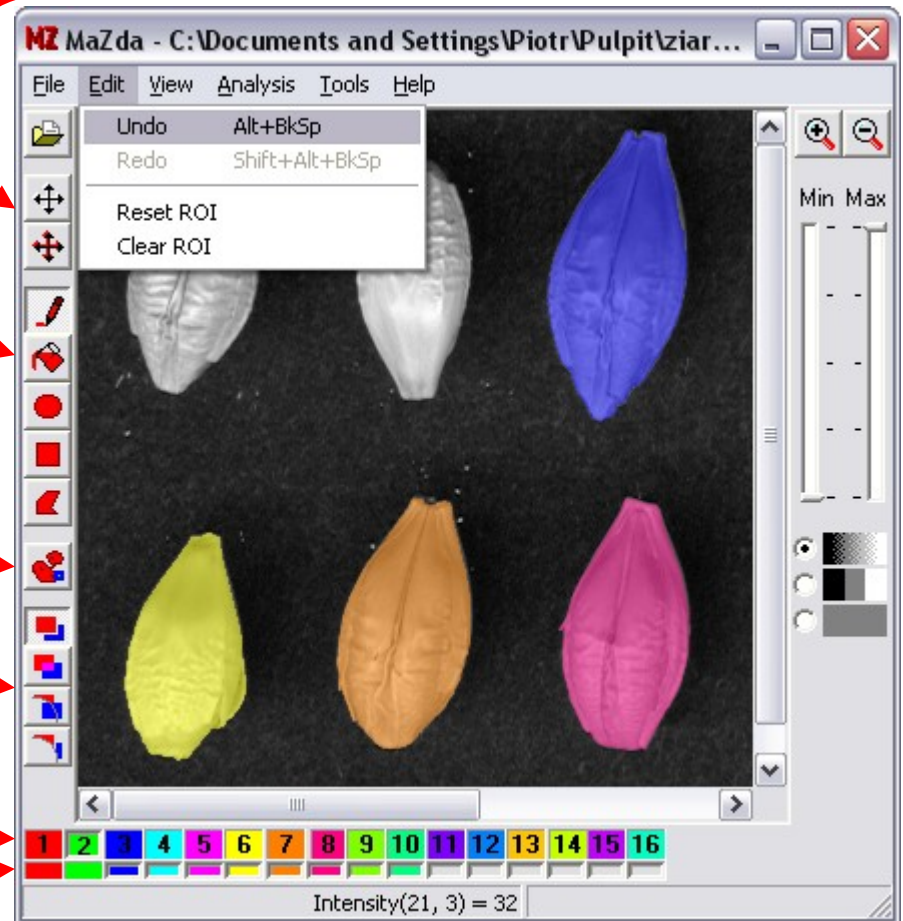
## ROI drawing mode buttons:

- non-overlapping regions
- overlapping regions
- erasing selected region
- erasing all the regions

ROI color selection bar. Right-clicking on the color button lets to assign a class name for a ROI

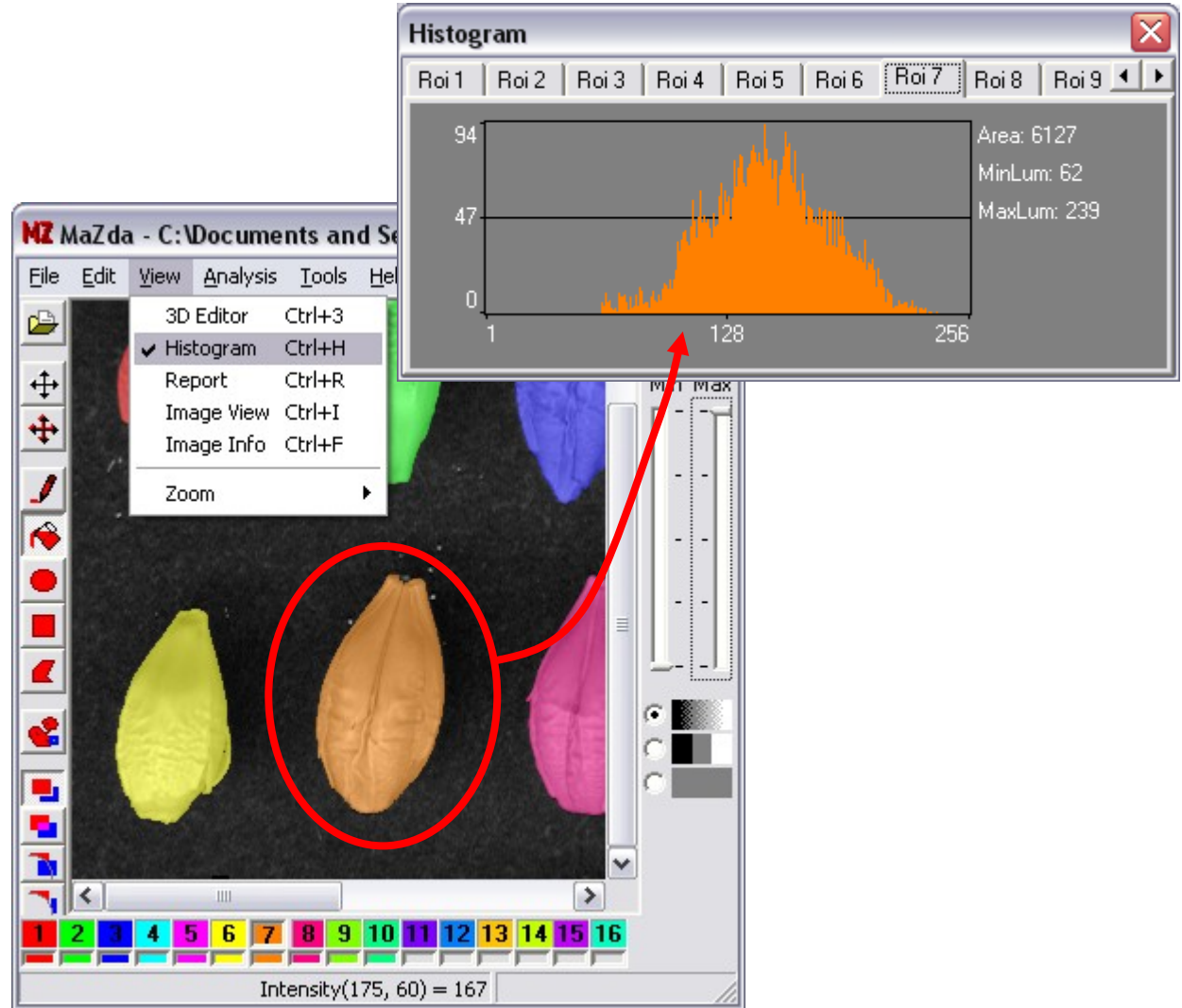
Created ROI indicator bar. Buttons may be used for switching ROI on and off for viewing

Move or copy the selected ROI



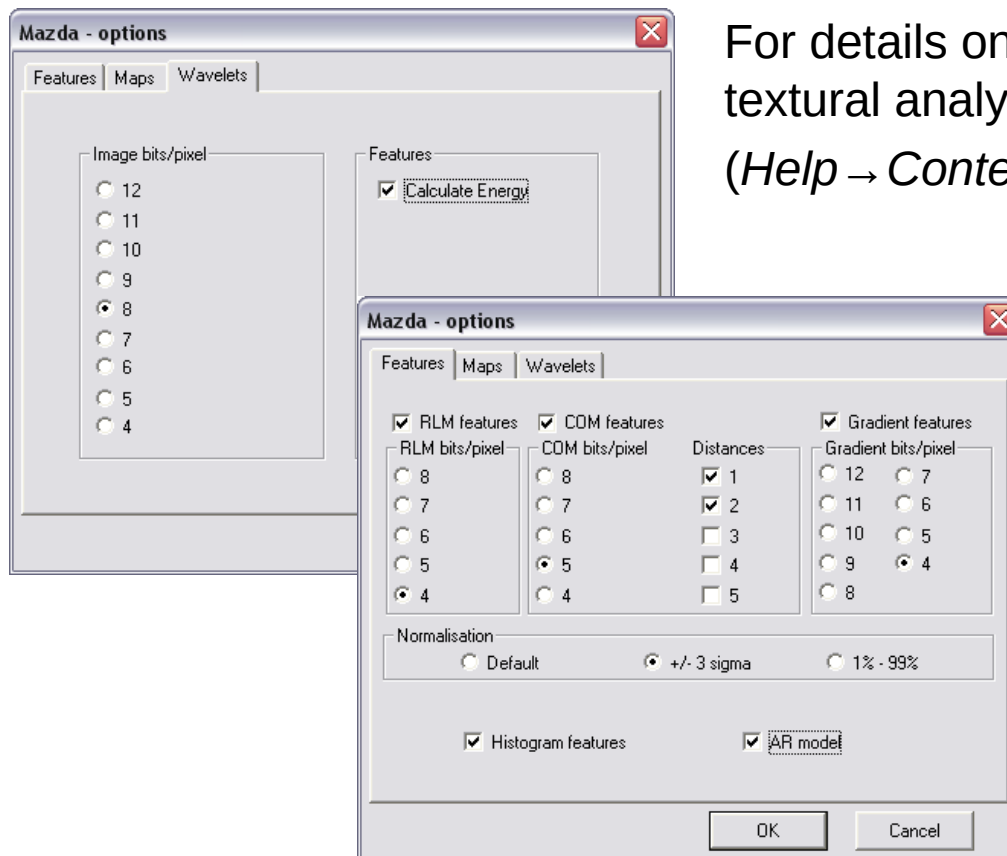
# Image histogram

To view an image histogram within region of interest select  
*View* → *Histogram*  
from the menu.



# ROI analysis options

To set the analysis options select *Analysis* → *Options...* from the MaZda menu. For details on the methods implemented for textural analysis refer to the MaZda manual (*Help* → *Contents*)



# Image analysis

**MaZda - C:\Documents and Settings\Piotr\Pulpit\COST\_Training\Tutorials\2\_Image\_Analysis\elgrain...**

File Edit View Analysis Tools Help

**MaZda Report**

File Feature selection Tools

2006-6-13 18\_10\_24

Image File: elgrain.bmp  
ROI File: elgrain.roi  
Image size: 641 x 358  
Min. lum.: 1  
Max. lum.: 255  
Bits/pixel: 8

Normalisation = 3 sigma  
Histogram analysis = Yes  
CO matrix analysis = Yes, Dimensions = 6 x 6, Distances = 1 2  
RL matrix analysis = Yes, Dimension = 6  
Gradient analysis = Yes, Max pixel value = 16

| Feature name    | ✓ 1      | ✓ 2       | ✓ 3       | ✓ 4       | ✓ 5       | ✓ 6       | ✓ 7       |
|-----------------|----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Area            | 5662     | 2489      | 2853      | 2535      | 2656      | 6246      | 6045      |
| MinNorm         | 100      | 41        | 2         | 28        | -18       | 52        | 55        |
| MaxNorm         | 222      | 267       | 192       | 142       | 276       | 282       | 278       |
| Mean            | 161.6    | 154.46    | 97.508    | 85.175    | 129.3     | 167.28    | 167.16    |
| Variance        | 415.49   | 1424.6    | 998.09    | 360.23    | 2421.7    | 1473.6    | 1379.8    |
| Skewness        | -1.1798  | -0.43217  | 0.59604   | 1.3669    | -0.17895  | -0.16635  | -0.72544  |
| Kurtosis        | 0.27687  | -0.025056 | -0.082939 | 1.8885    | -1.2378   | -0.67554  | -0.18297  |
| Perc.01%        | 107      | 57        | 48        | 57        | 47        | 73        | 69        |
| Perc.10%        | 127      | 100       | 62        | 67        | 57        | 122       | 111       |
| Perc.50%        | 171      | 159       | 92        | 80        | 138       | 169       | 178       |
| Perc.90%        | 179      | 201       | 147       | 112       | 187       | 218       | 208       |
| Perc.99%        | 185      | 222       | 159       | 149       | 215       | 238       | 227       |
| Area_S(1,0)     | 11154    | 4826      | 5576      | 4936      | 5156      | 12220     | 11822     |
| S(1,0)AngScdMom | 0.010606 | 0.0035383 | 0.0032403 | 0.0033453 | 0.0044692 | 0.0048353 | 0.0040038 |
| S(1,0)Contrast  | 33.799   | 60.082    | 17.152    | 51.333    | 39.671    | 14.634    | 14.527    |
| S(1,0)Correlat  | 0.83875  | 0.7257    | 0.9185    | 0.7564    | 0.82147   | 0.9288    | 0.92861   |
| S(1,0)CovD15... | 104.8    | 109.52    | 105.22    | 105.26    | 111.1     | 102.76    | 101.74    |

To start the analysis select *Analysis* → *Run* from the MaZda menu.

The results are presented in a Report window:

- ✓ Tab-page per analysis
- ✓ Column per ROI
- ✓ Row per feature

# Classes of ROIs

The screenshot displays the MZ Report software interface. At the top, there's a menu bar with 'File', 'Feature selection', and 'Tools'. Below it, a date field shows '2006-6-13 18\_10\_24'. The main area contains a list of features with their values across 12 columns. A red circle highlights the header of column 7, and a red arrow points from it to the 'Class Name' dialog box. The dialog box has a title bar 'Class Name' and a close button. It contains a text field for 'Roi4 class name:' with 'OK' and 'Cancel' buttons. Below this, the word 'Grain' is displayed. There are three radio buttons under 'Apply changes to:': 'this column only' (selected), 'all columns of the class', and 'all columns of the document'. A red arrow also points from the 'this column only' option to the 'Class Name' dialog box.

Normalisation = 3 sigma  
Histogram analysis = Yes  
CO matrix analysis = Yes, Dimensions = 6 x 6, Distances = 1 2  
PL matrix analysis = Yes, Dimension = 6  
Gradient analysis = Yes, Max pixel value = 16  
AR model analysis = Yes

| Feature name | 1       | 2         | 3         | 4      | 5        | 6        | 7        | 8        | 9        | 10        | 11       | 12 |
|--------------|---------|-----------|-----------|--------|----------|----------|----------|----------|----------|-----------|----------|----|
| Area         | 5662    | 2489      | 2853      | 2535   | 2656     | 6246     | 6045     | 5244     | 6173     | 6566      | 6597     | 0  |
| MinNorm      | 100     | 41        | 2         | 28     | -18      | 52       | 55       | 46       | 21       | 50        | 57       | 0  |
| MaxNorm      | 222     | 267       | 192       | 142    | 276      | 282      | 278      | 283      | 273      | 271       | 280      | 0  |
| Mean         | 161.6   | 154.46    | 97.508    | 85.175 | 129.3    | 167.28   | 167.16   | 165.24   | 147.32   | 161.26    | 169.34   | 0  |
| Variance     | 415.49  | 1424.6    | 998.09    | 360.23 | 2421.7   | 1473.6   | 1379.8   | 1566     | 1760.7   | 1357.4    | 1381.9   | 0  |
| Skewness     | -1.1798 | -0.43217  | 0.59604   | 1.3669 | -0.17895 | -0.16635 | -0.72544 | -0.51188 | -0.30046 | -0.036412 | -0.79907 | 0  |
| Kurtosis     | 0.27687 | -0.025056 | -0.082939 | 1.8885 | -1.2378  | -0.67554 | -0.18297 | -0.59821 | -0.76142 | -0.83923  | -0.16068 | 0  |
| Perc.01%     | 107     | 57        | 48        | 57     | 47       | 73       | 69       | 66       | 58       | 78        | 71       | 0  |

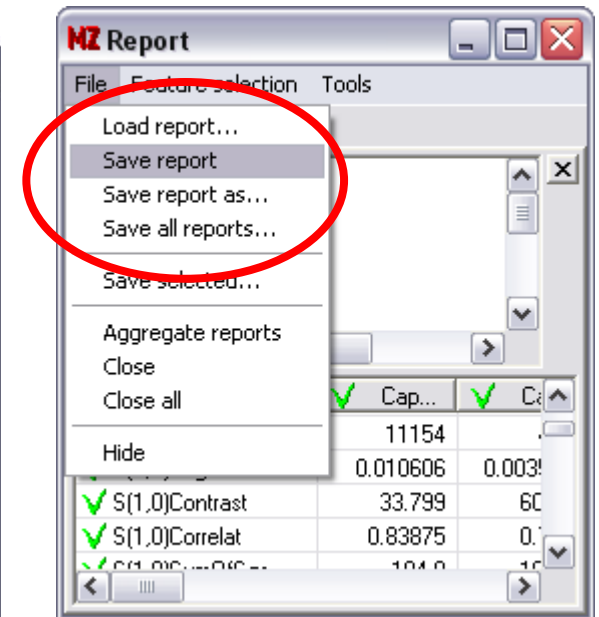
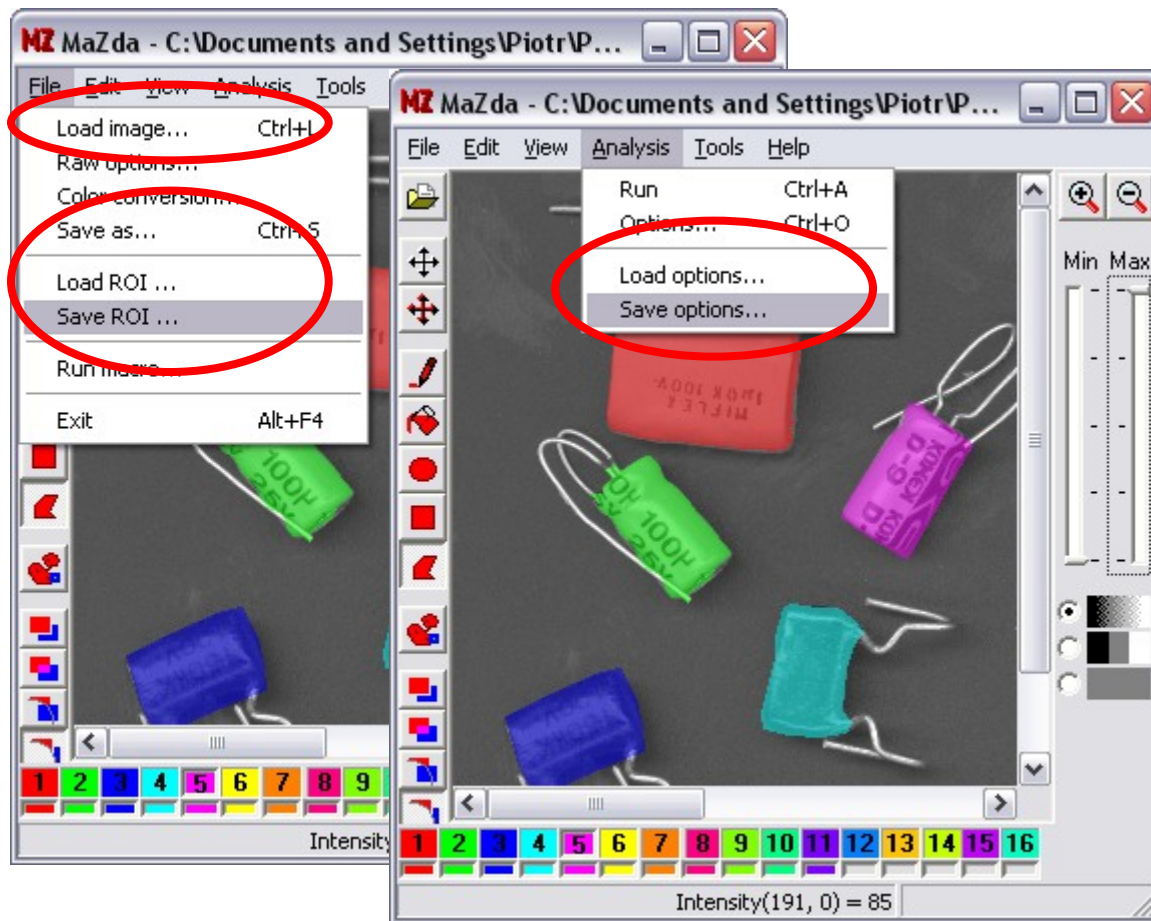
Image File: elgrain.bmp  
ROI File: elgrain.roi  
Image size: 641 x 358  
Min. lum.: 1  
Max. lum.: 255  
Bits/pixel: 8

| Feature name | Cap...  | Cap...    | Cap...    | Cap... | Cap...   | Grain    | Grain    | Grain    | Grain    | Grain     | Grain    | 12 |
|--------------|---------|-----------|-----------|--------|----------|----------|----------|----------|----------|-----------|----------|----|
| Area         | 5662    | 2489      | 2853      | 2535   | 2656     | 6246     | 6045     | 5244     | 6173     | 6566      | 6597     | 0  |
| MinNorm      | 100     | 41        | 2         | 28     | -18      | 52       | 55       | 46       | 21       | 50        | 57       | 0  |
| MaxNorm      | 222     | 267       | 192       | 142    | 276      | 282      | 278      | 283      | 273      | 271       | 280      | 0  |
| Mean         | 161.6   | 154.46    | 97.508    | 85.175 | 129.3    | 167.28   | 167.16   | 165.24   | 147.32   | 161.26    | 169.34   | 0  |
| Variance     | 415.49  | 1424.6    | 998.09    | 360.23 | 2421.7   | 1473.6   | 1379.8   | 1566     | 1760.7   | 1357.4    | 1381.9   | 0  |
| Skewness     | -1.1798 | -0.43217  | 0.59604   | 1.3669 | -0.17895 | -0.16635 | -0.72544 | -0.51188 | -0.30046 | -0.036412 | -0.79907 | 0  |
| Kurtosis     | 0.27687 | -0.025056 | -0.082939 | 1.8885 | -1.2378  | -0.67554 | -0.18297 | -0.59821 | -0.76142 | -0.83923  | -0.16068 | 0  |
| Perc.01%     | 107     | 57        | 48        | 57     | 47       | 73       | 69       | 66       | 58       | 78        | 71       | 0  |

To assign a class name to a column, a feature vector computed for a particular ROI, click on the column header. Then, use a *Class Name* dialog box to set appropriate class name.

# Saving data

Images, region of interest, option sets or reports may be saved to a disk files or loaded from disk files. Save your work before it's too late!



# Exercise 1

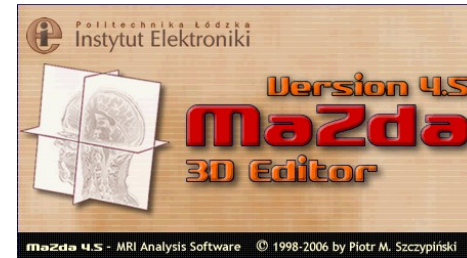
- Start MaZda
- Load image *elgrain.bmp* from *Tutorials\2\_Image\_Analysis* folder
- What is a height and width of the image in pixels?
- Define regions of interest, one per individual object.
  - For capacitors use *Draw polygon* tool
  - For grains set image view to three grey levels (thresholded), adjust thresholds to distinguish grain areas, and use *Fill* tool
- Set analysis options (Normalisation: +/- 3 Sigma, 6 bit COM analysis, Calculate wavelets energy, AR Model, and set other parameters of your choice)
- Run the analysis
- Set up appropriate class names in a report window
- Observe the  $S(1,0)Contrast$  feature has higher values for Capacitors then for grains, and the  $Teta1$  has higher values for grains.
- Find some other features that may be useful for discrimination of the two classes
- In the *Report* window select *Feature selection* → *Fisher* from the menu. It will start a procedure searching for the most discriminative features. Do the selected features discriminate the two classes?



# Exercise 2

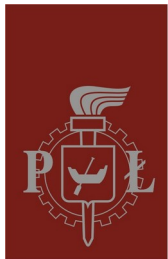
- Start MaZda or, if it is already started, close all the report tab-pages
- Load image *texture1.bmp* from *Tutorials\2\_Image\_Analysis* folder
- Switch to the overlapping mode and create 16 regions of interest of an approximate size 60x60 pixels (observe the status bar for a size information) with *Draw rectangle* tool
- Set analysis options and run the analysis
- In a Report window set class name *Biology* for all the columns
- Load image *texture2.bmp* from *Tutorials\2\_Image\_Analysis* folder
- Run the analysis (use the same regions and analysis options as previously)
- In a Report window set class name *Mineral* for all the columns of the second tab-page
- Find features that may be useful for discrimination of the two classes
- In the *Report* window select *Feature selection* → *Mutual information* from the menu. It will start a procedure searching for the most discriminative features. Do the selected features discriminate the two classes?

# *MaZda 4.5 Tutorials* Color Image Analysis



June 2006

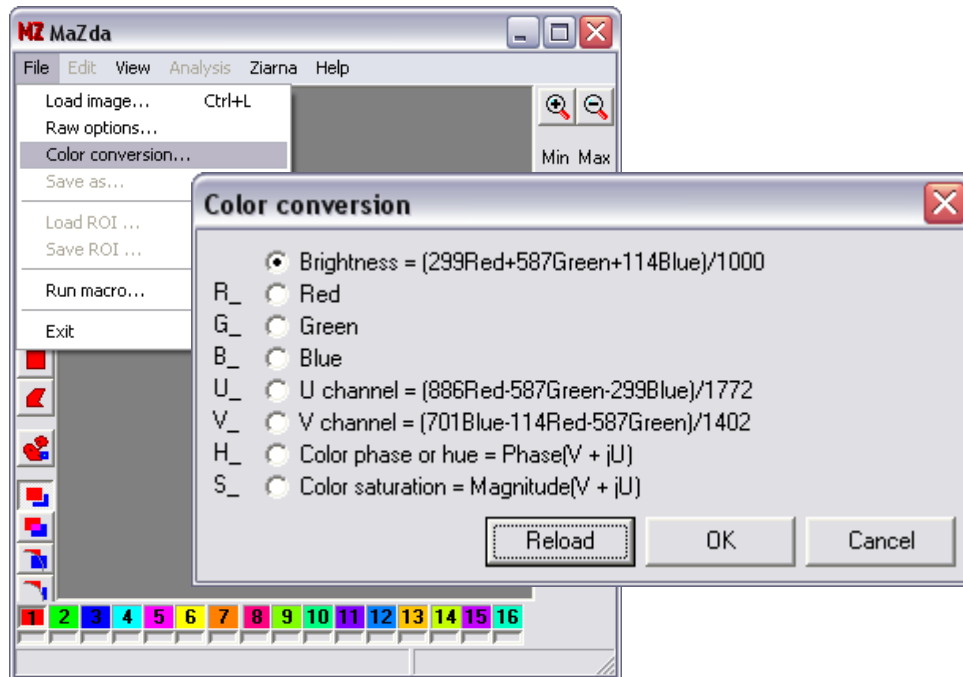
Piotr M. Szczypiński



Technical University of Lodz  
Institute of Electronics

# Color images

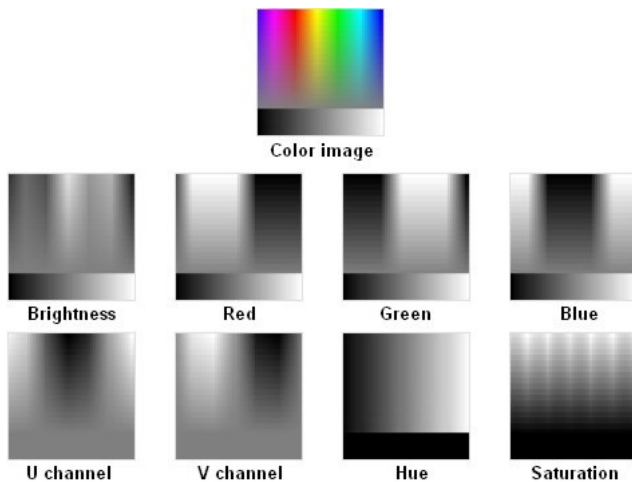
Procedures for texture analysis implemented in MaZda operate on grey-scale images only. The color image having three color components (red, green and blue), when loaded into MaZda, must be converted into the gray-scale image. Grey-scale images, which are results of such conversions are usually called color components or color channels. MaZda provides eight ways of such conversion, which may be selected through the File → Color conversion... menu option and a File → Color conversion dialog box.



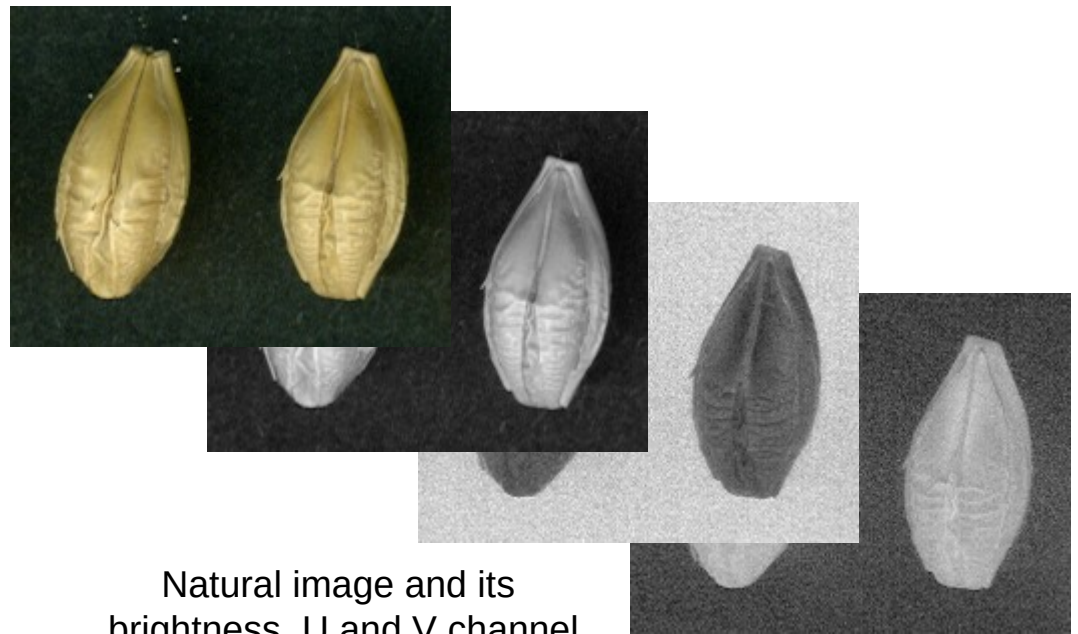
# Loading color image

Select *File* → *Color conversion...* menu option, with a *Color conversion* dialog box set the color to grey-scale conversion required, and press OK. Then, load color bitmap image into the MaZda software.

To load another channel of the image that was already loaded select *File* → *Color conversion...* menu option, set the conversion required and press Reload



Test image and results of color to grey-scale conversions

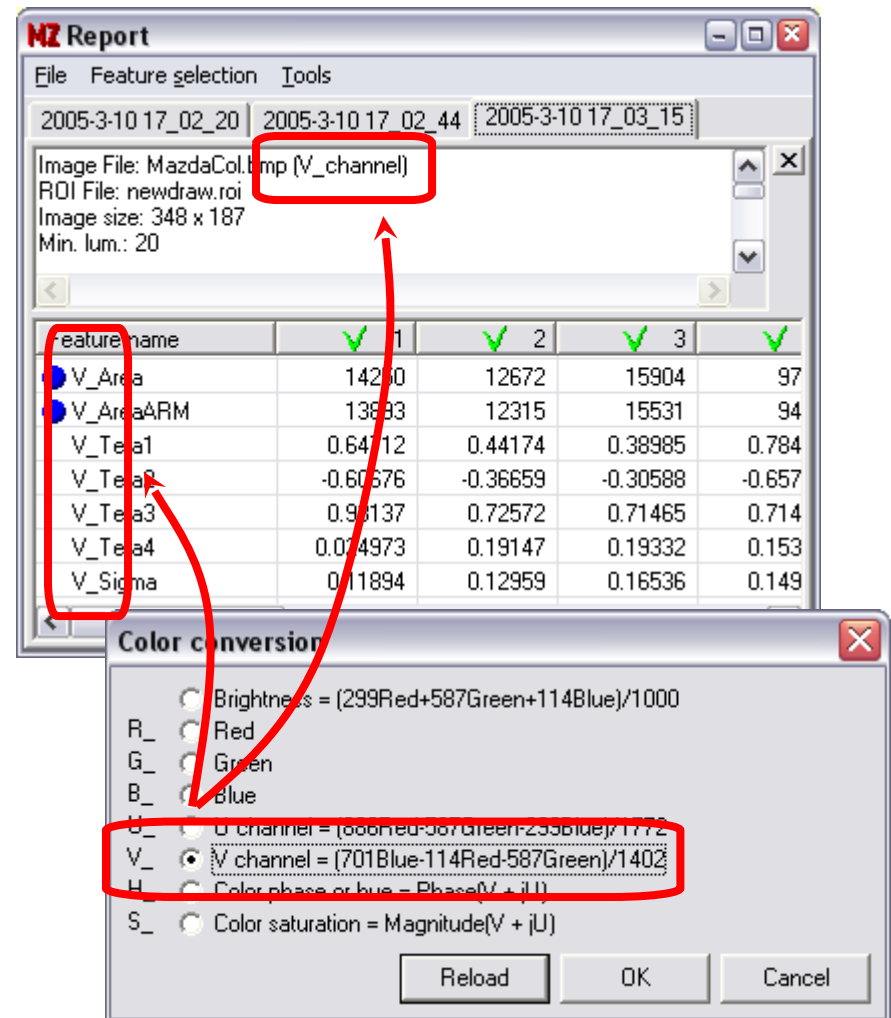


Natural image and its brightness, U and V channel

# Analysis

The analysis is run the same way as for grey-scale images. The resulting features are presented within a *Report* window.

Depending on a color channel that was analyzed, corresponding prefix is added to every feature name. The exception is a brightness channel, for which no prefix is added.

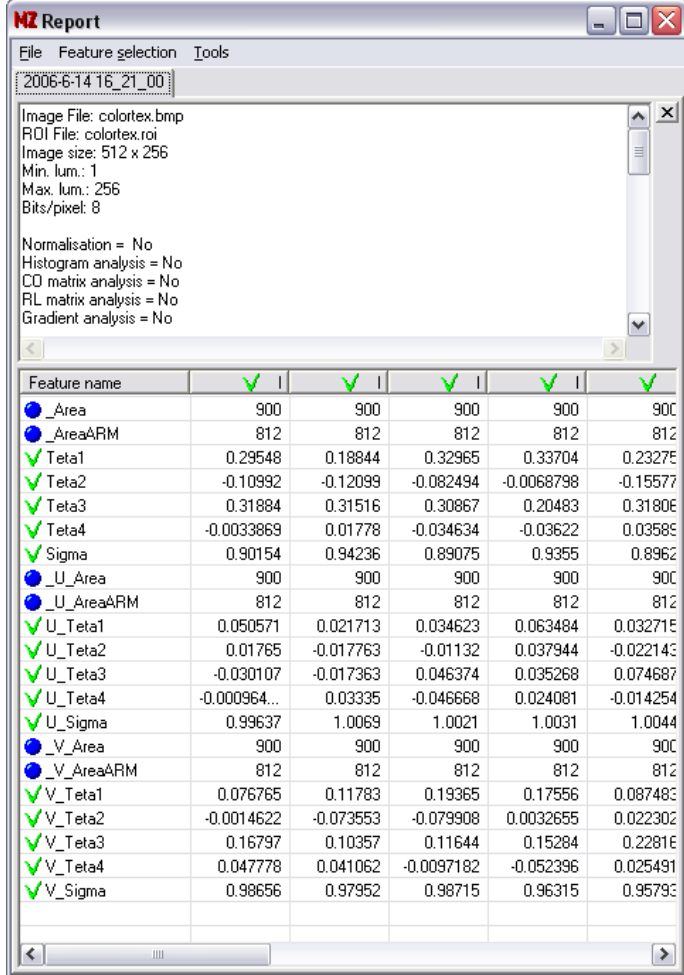


# Combining analysis results

The analysis results computed for various channels of the same color image may be merged in a single tab-page.

To merge data from the currently viewed tab-page with data from the left-adjacent tab-page select *File* → *Aggregate reports* from the *Report* menu.

Example of report that combines analysis results from three color channels of the same image



The screenshot shows the MZ Report window with a menu bar (File, Feature selection, Tools) and a timestamp of 2006-6-14 16:21:00. The window contains a text area with image and ROI file information, analysis parameters, and a table of results.

Image File: colortex.bmp  
ROI File: colortex.roi  
Image size: 512 x 256  
Min. lum.: 1  
Max. lum.: 256  
Bits/pixel: 8

Normalisation = No  
Histogram analysis = No  
CD matrix analysis = No  
RL matrix analysis = No  
Gradient analysis = No

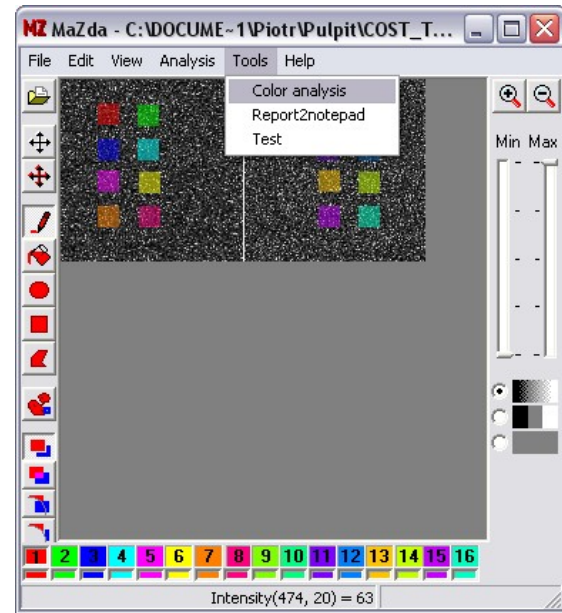
| Feature name | ✓ I          | ✓ I       | ✓ I        | ✓ I        | ✓ I       |
|--------------|--------------|-----------|------------|------------|-----------|
| • _Area      | 900          | 900       | 900        | 900        | 900       |
| • _AreaARM   | 812          | 812       | 812        | 812        | 812       |
| ✓ Teta1      | 0.29548      | 0.18844   | 0.32965    | 0.33704    | 0.23275   |
| ✓ Teta2      | -0.10992     | -0.12099  | -0.082494  | -0.0068798 | -0.15577  |
| ✓ Teta3      | 0.31884      | 0.31516   | 0.30867    | 0.20483    | 0.3180E   |
| ✓ Teta4      | -0.0033869   | 0.01778   | -0.034634  | -0.03622   | 0.03589   |
| ✓ Sigma      | 0.90154      | 0.94236   | 0.89075    | 0.9355     | 0.8962    |
| • _U_Area    | 900          | 900       | 900        | 900        | 900       |
| • _U_AreaARM | 812          | 812       | 812        | 812        | 812       |
| ✓ U_Teta1    | 0.050571     | 0.021713  | 0.034623   | 0.063484   | 0.032715  |
| ✓ U_Teta2    | 0.01765      | -0.017763 | -0.01132   | 0.037944   | -0.022143 |
| ✓ U_Teta3    | -0.030107    | -0.017363 | 0.046374   | 0.035268   | 0.074687  |
| ✓ U_Teta4    | -0.000964... | 0.03335   | -0.046668  | 0.024081   | -0.014254 |
| ✓ U_Sigma    | 0.99637      | 1.0069    | 1.0021     | 1.0031     | 1.0044    |
| • _V_Area    | 900          | 900       | 900        | 900        | 900       |
| • _V_AreaARM | 812          | 812       | 812        | 812        | 812       |
| ✓ V_Teta1    | 0.076765     | 0.11783   | 0.19365    | 0.17556    | 0.087483  |
| ✓ V_Teta2    | -0.0014622   | -0.073553 | -0.079908  | 0.0032655  | 0.022302  |
| ✓ V_Teta3    | 0.16797      | 0.10357   | 0.11644    | 0.15284    | 0.2281E   |
| ✓ V_Teta4    | 0.047778     | 0.041062  | -0.0097182 | -0.052396  | 0.025491  |
| ✓ V_Sigma    | 0.98656      | 0.97952   | 0.98715    | 0.96315    | 0.95793   |

# Make it quick

To simplify the analysis of color images a plugin *Color analysis* has been written for MaZda. The plugin will automatically load consecutive color channels of the image, run the analysis and merge reports.

To quickly analyze all the channels of color image:

- Load a color image to be analyzed
- Draw regions of interest
- Set analysis options
- Start the Color analysis plugin (*Tools* → *Color analysis*)



# Exercise 1

1. Start MaZda or, if it is already started, close all the report tab-pages
2. Load brightness channel of *dtex.bmp* from *Tutorials\3\_Color\_Analysis* folder (The image contains two similar textures)
3. Define 16 regions of interest of an approximate size 60x60 pixels, 8 regions per texture
4. Set analysis options and run the analysis (*Analysis* → *Run*)
5. Select the most discriminative features with a Fisher coefficient procedure (Observe values of Fisher coefficient computed for the selected features).
6. Start B11 (*Tools* → *B11 analysis* in the *Report* window)
7. Observe the raw data distribution (*Analysis* → *Raw data* in *B11*)
8. Close the report tab-page in the *Report* window of MaZda and start *Color analysis* plugin (*Tools* → *Color analysis*)
9. Repeat steps 5 – 7
10. In which case the Fisher coefficients were higher?
11. Which color channel holds the most valuable information for discrimination of the two textures?

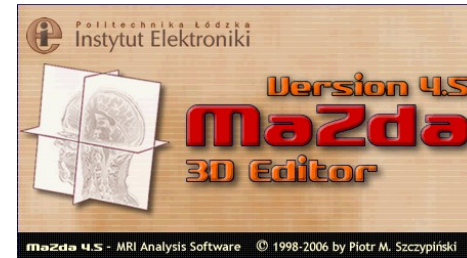


# Exercise 2

1. Start MaZda or, if it is already started, close all the report tab-pages
2. There are three classes of endoscopic images in *Tutorials\3\_Color\_Analysis* folder, six images per class (file names beginning with letter *A*, *B* or *C*)
3. Load these images one by one, and perform *Color analysis* within the circular region of interest covering a field of view
4. Assign corresponding class names to the feature vectors produced by MaZda
5. Select the most discriminative features with a selection method of your choice
6. View the data distribution with B11
7. Which color channel holds the most valuable information for discrimination of the three classes?

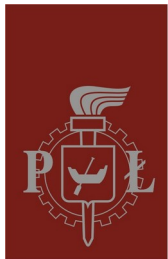
# *MaZda 4.5 Tutorials*

## *3D Image Analysis*



June 2006

Piotr M. Szczypiński



Technical University of Lodz  
Institute of Electronics

# 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

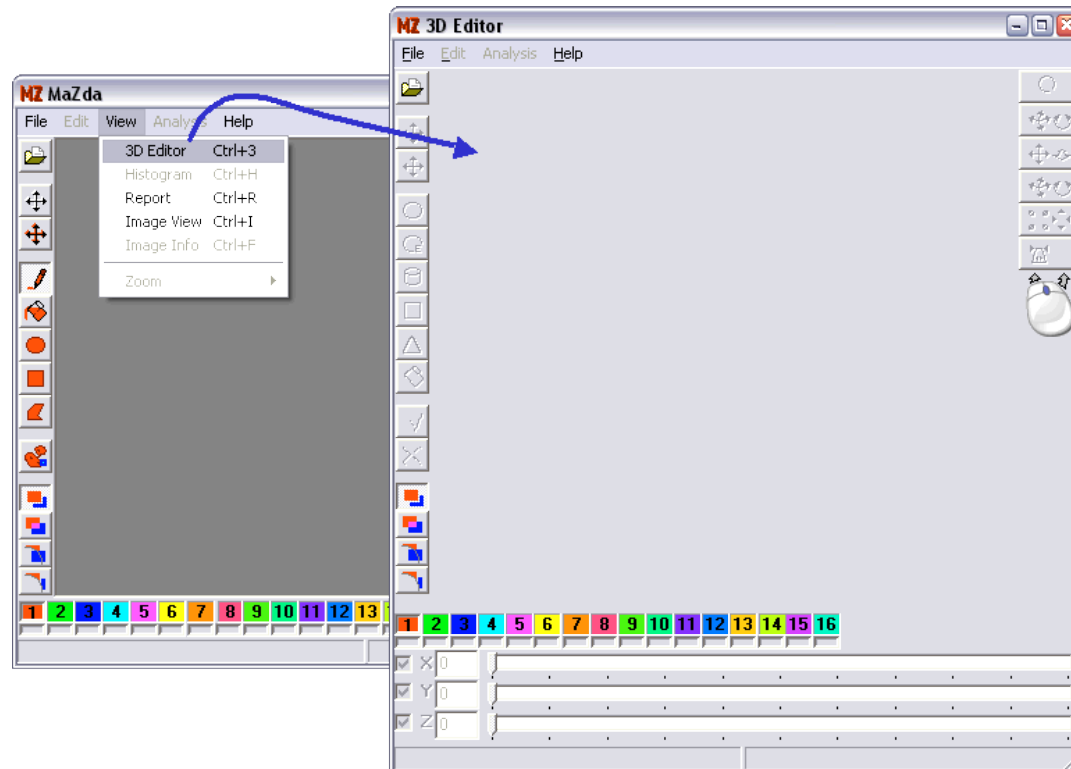
The **3D Editor** of **MaZda** lets the user define three-dimensional regions of interest (ROI). The **3D Editor** provides tools for:

- 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.

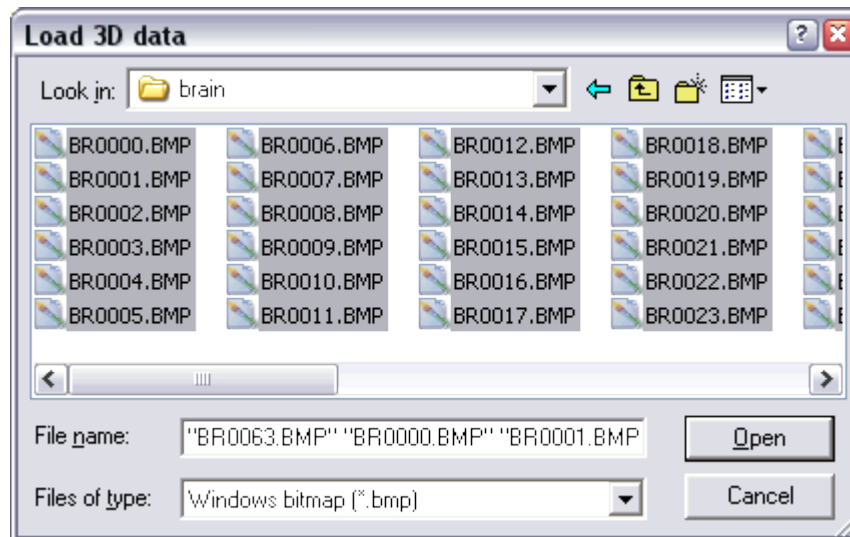


# Loading 3D data

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.

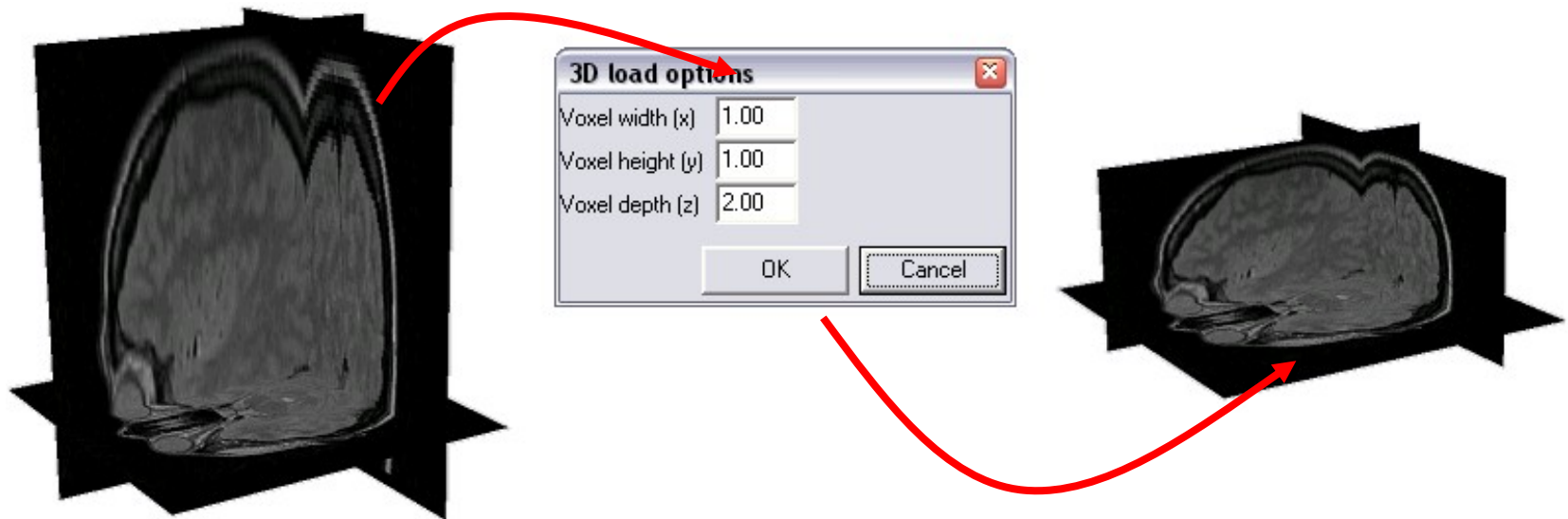
The **Load 3D data** dialog window appears to choose input file type and to select file or files to be loaded.

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

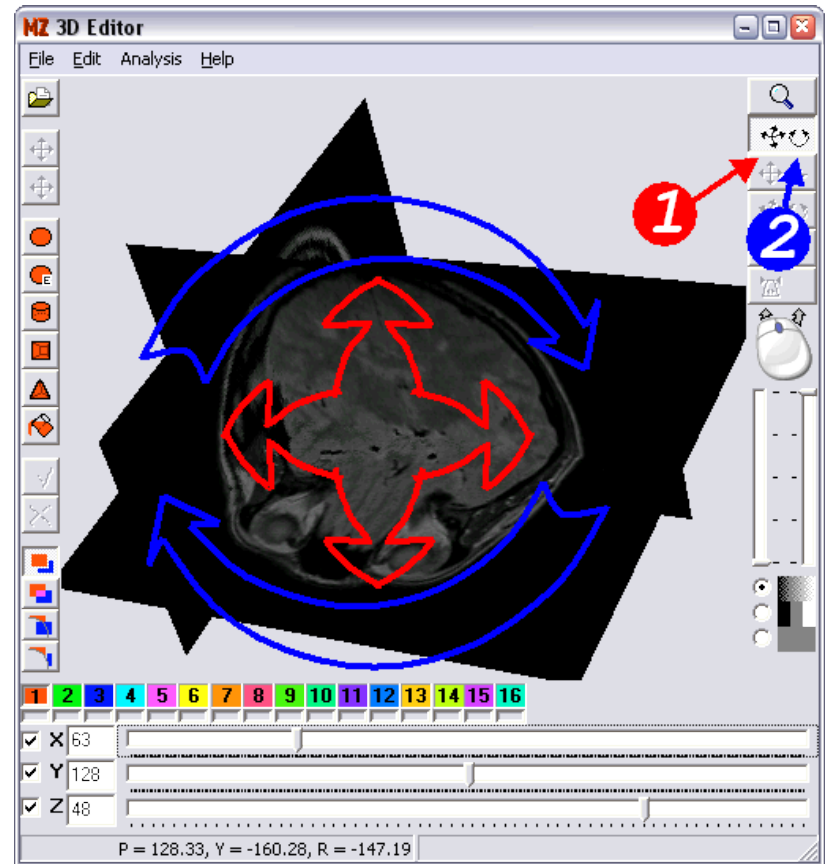
The image may be presented with wrong proportions. The cause of this appearance is a way the image is produced by a medical scanner. Three-dimensional volume is scanned over several parallel cross-sections. The distance between cross-sections is usually different from a distance between adjacent pixels 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.

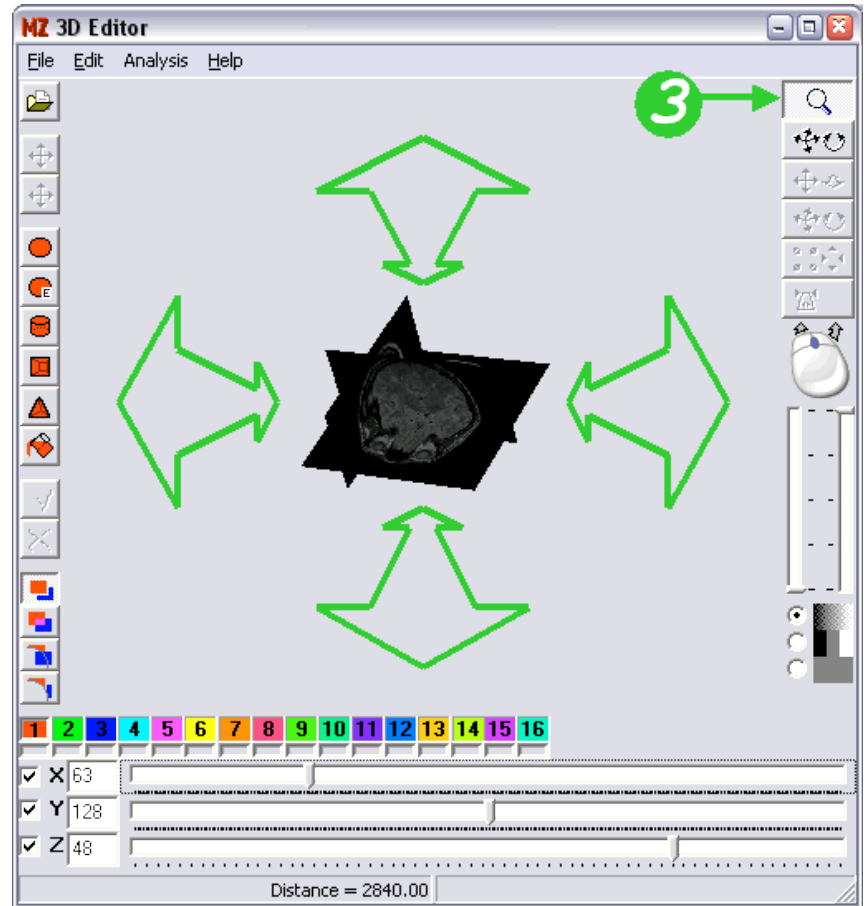
- To adjust pitch or yaw angles press the left mouse button and slide the mouse cursor across the **3D Editor** window.
- To adjust roll angle press the right mouse button and move the mouse cursor horizontally across the window.



# 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.

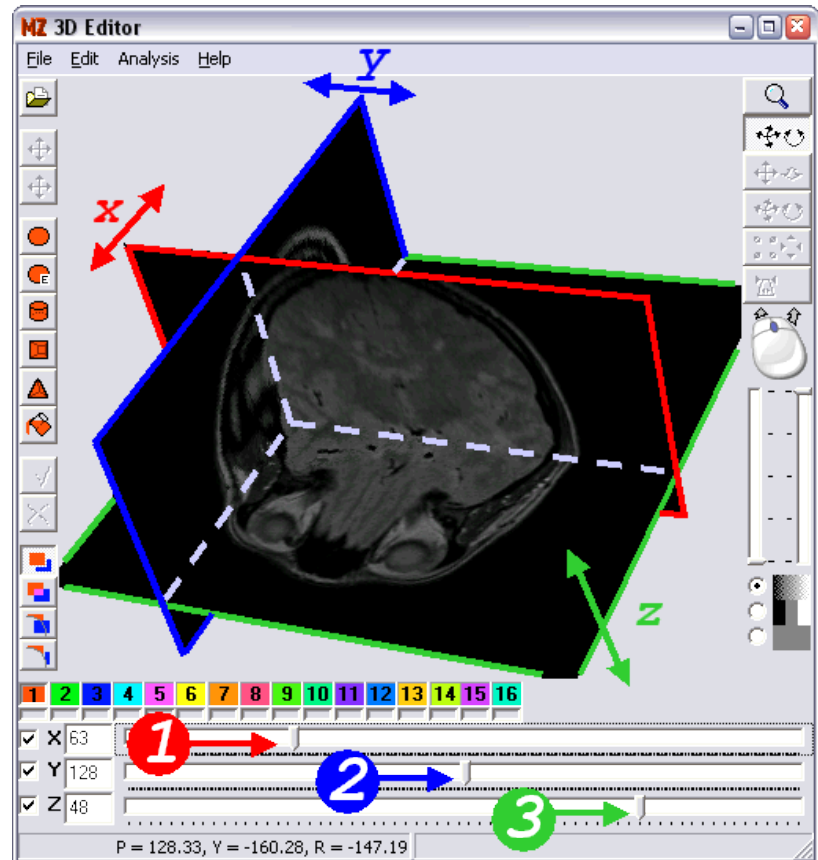




# Adjusting the 3D data view

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

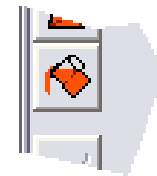
The location of cross-section can be adjusted by one of three slide-bars located at the lower part of **3D Editor** window.



# 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.

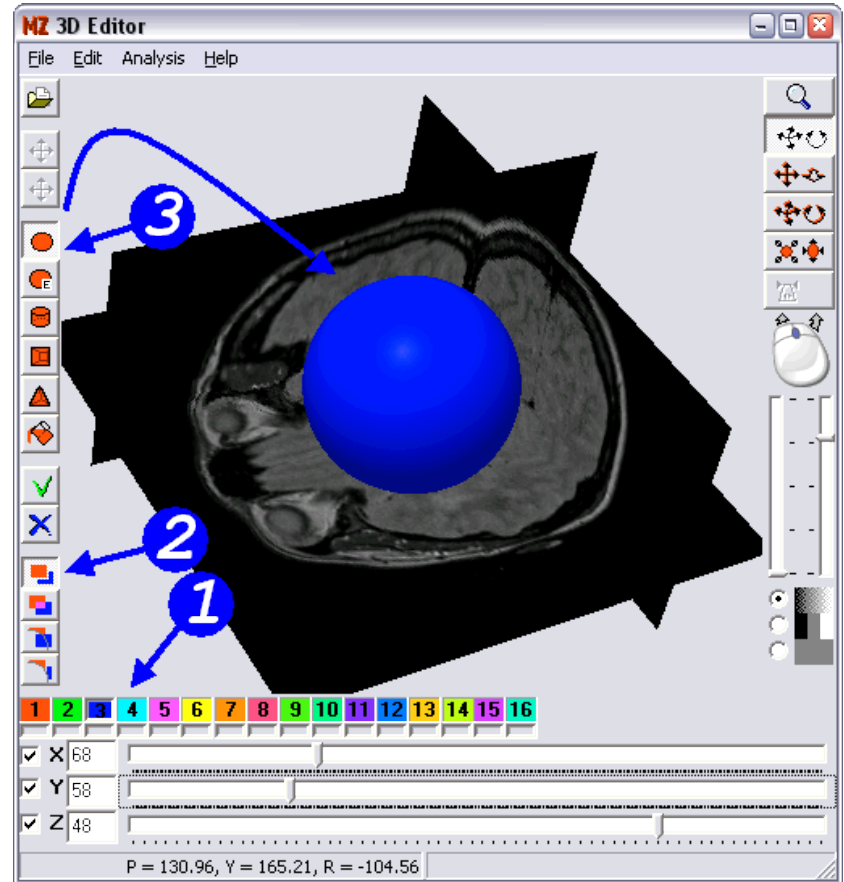
Below the slide-bars there are three radio buttons. Choosing the middle one will cause the image to be displayed in three gray-levels. The slide-bars in this mode serve as gray-level threshold selectors. Choosing the lower radio button will cause the data to disappear. The viewed cross-sections are uniformly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



# Editing regions of interest

To edit regions of interest for the textural analysis:

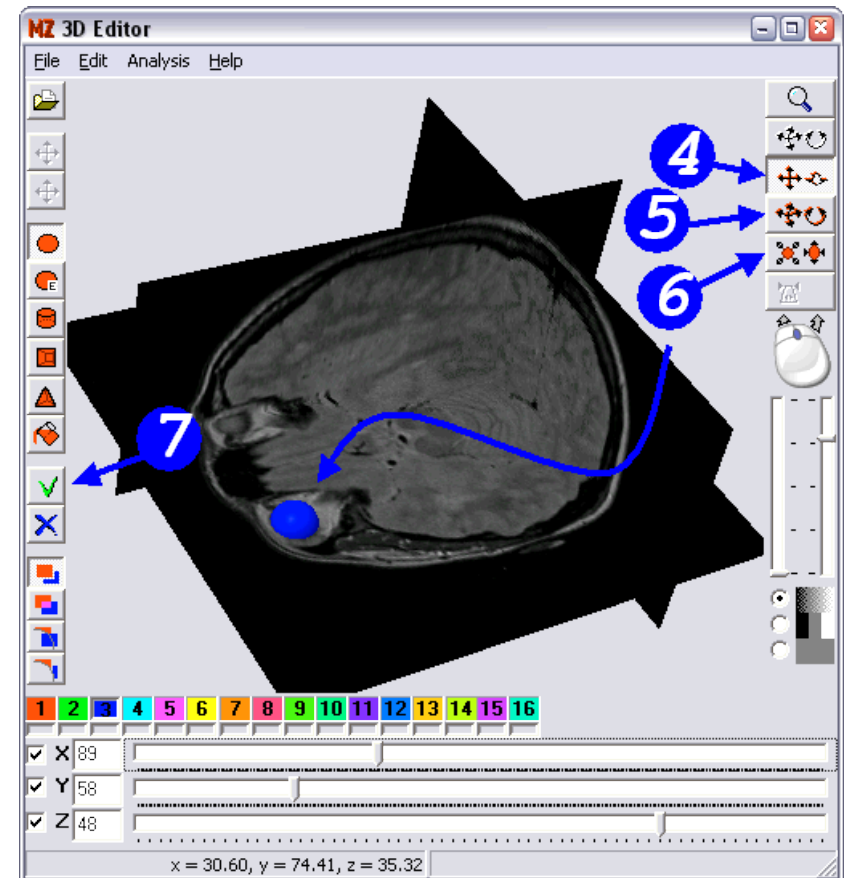
1. Select the color (number) of region to be created from the palette
2. Select the "drawing" mode: non-overlapping ROI, overlapping ROI or modes for erasing fragments of already existing regions
3. Select one of predefined blocks (sphere, tube, cube or tetrahedron)
4. Adjust the block location, orientation,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



# Editing regions of interest

To edit regions of interest for the textural analysis:

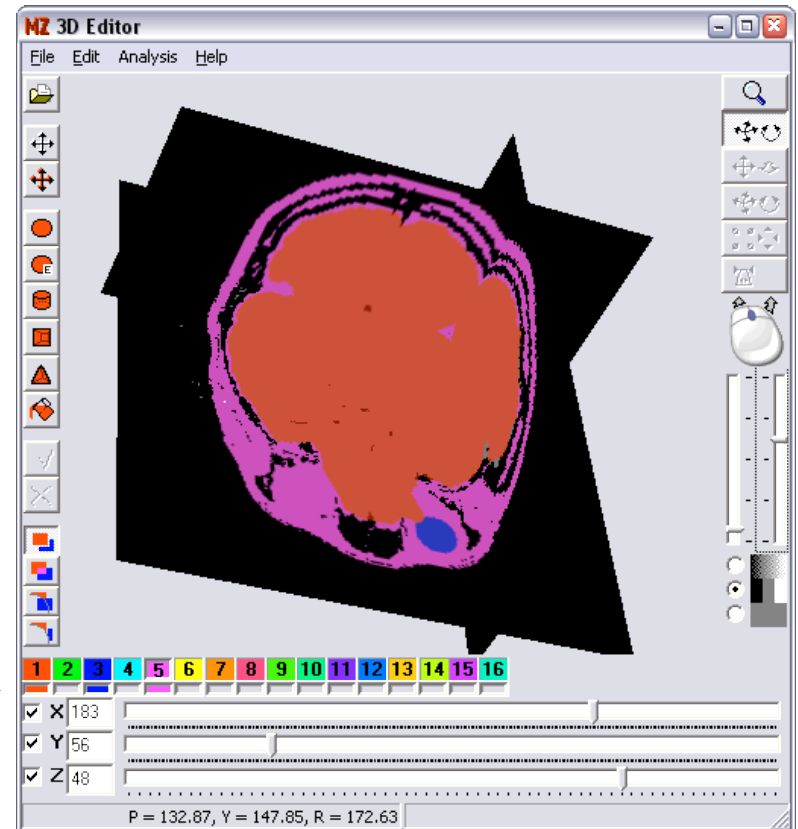
1. Select the color (number) of region to be created from the palette
2. Select the "drawing" mode: non-overlapping ROI, overlapping ROI or modes for erasing fragments of already existing regions
3. Select one of predefined blocks (sphere, tube, cube or tetrahedron)
- 4-6. Adjust the block location, orientation, size and shape
7. Press *Accept* button to merge the resulting block with a ROI of selected color



# Switching regions on and off

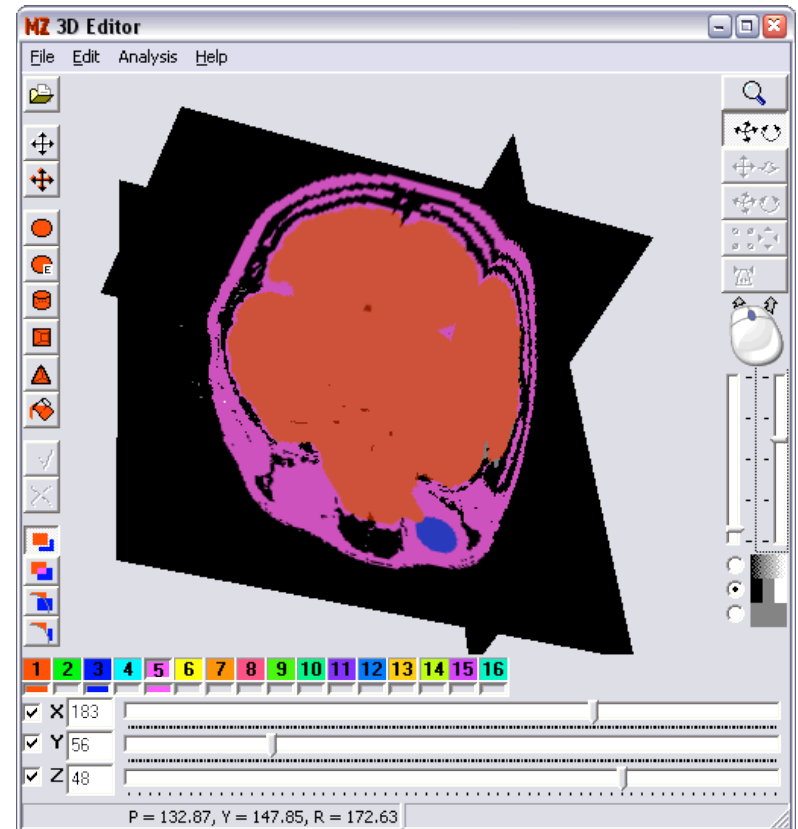
The created regions are visible in a form of color highlights.

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.



# 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.

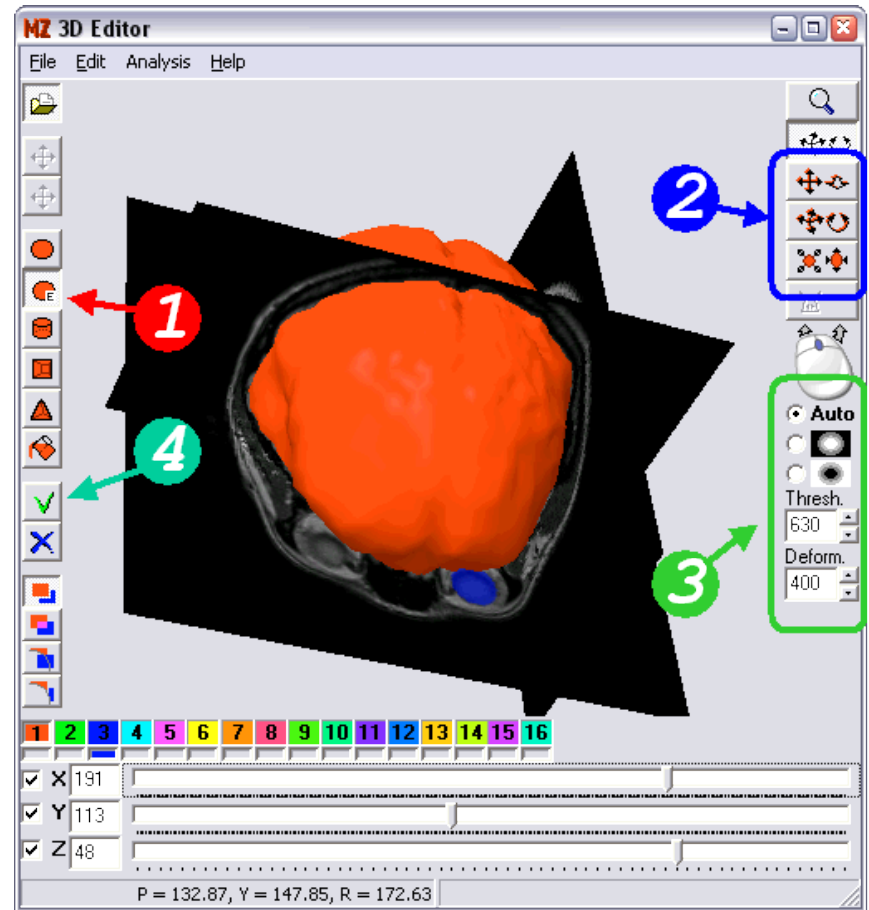


# Elastic surface model

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:

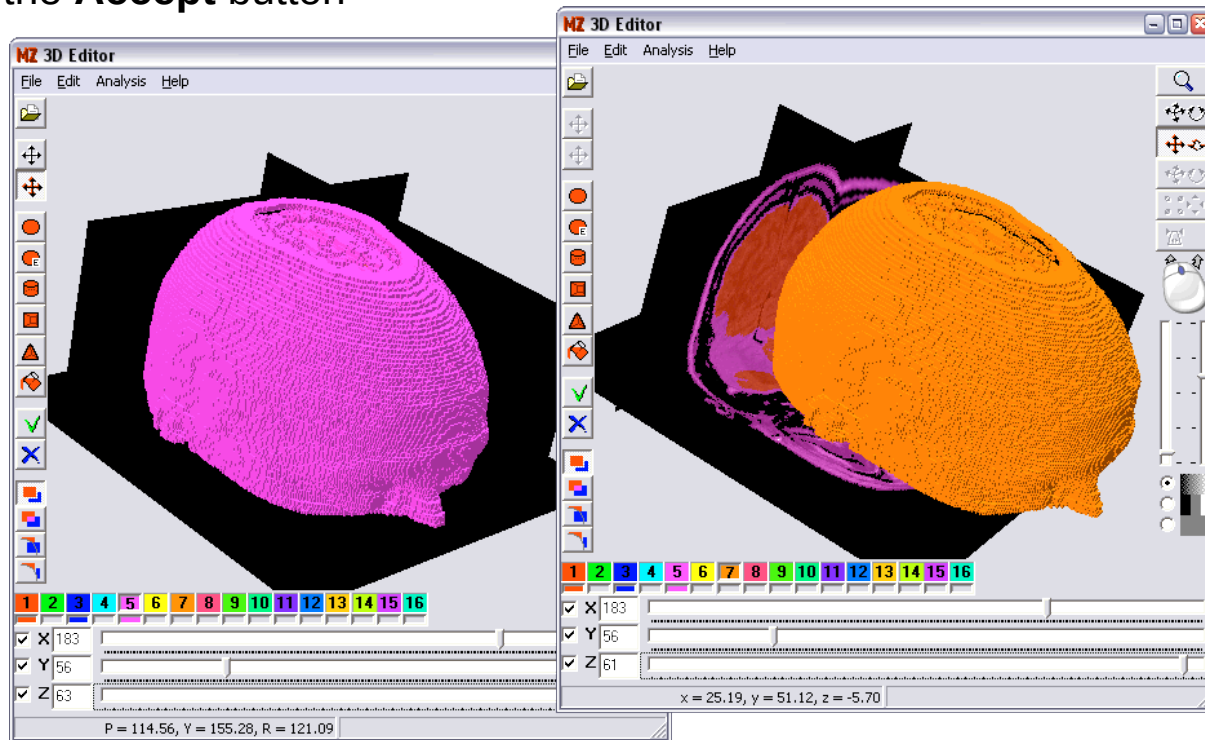
1. Select **Create spherical-elastic ROI** tool
2. Adjust position and size of a model
3. If needed, switch off automatic mode and adjust **Thresh.** and **Deform.** parameters
4. Press the **Accept** button



# Moving and copying regions

Any existing region can be moved or copied. To move or copy the region:

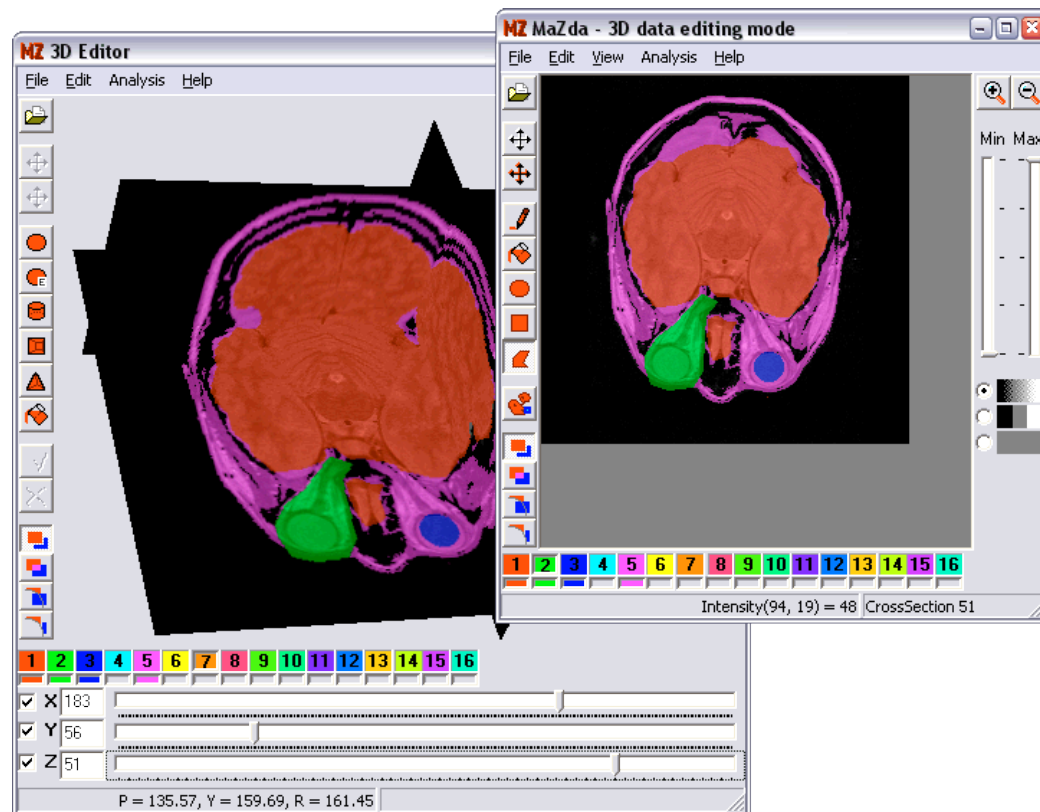
1. Select, from a palette toolbox, a color (number) of a region to be moved or copied.
2. Select a **Move** or **Copy** button  
(after a while a three-dimensional model of selected region will appear)
3. Change the location of the region by means of move, push or pull tools and a mouse.
4. Press the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





# Editing 3D ROI in 2D

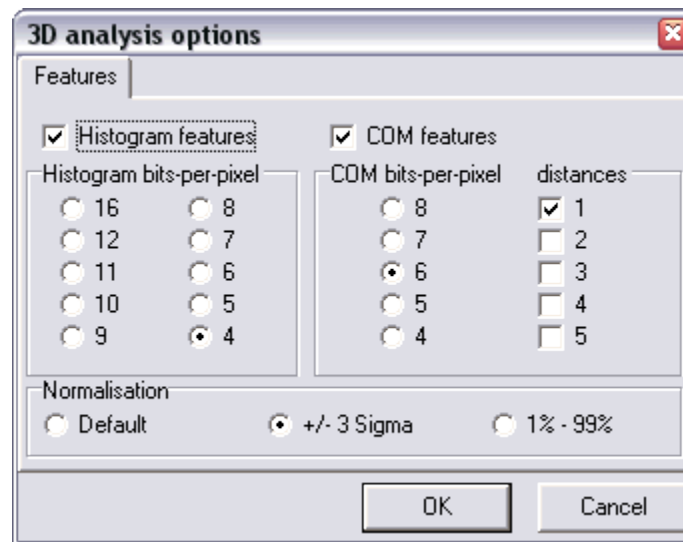
The region of interest can be edited cross-section by cross-section. To edit a selected  $Z^{th}$  cross-section, just switch to the main **MaZda** window, edit ROI by means of 2D editing tools and switch back to **3D Editor** window. The selected cross-section will be updated.



# 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.

# Exercise 1

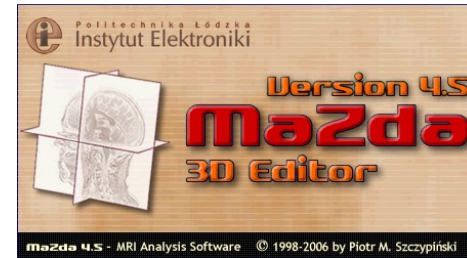
1. Start MaZda and switch it to a 3D Editor
2. Load MRI cross-sections of a head (*BR0000.BMP* - *BR0063.BMP*) from *Tutorials\4\_3D\_Analysis* folder
3. Define regions covering eye bolls with *Create elypsoidal ROI* tool
4. Define region covering a cerebrum with elastic surface tool (if needed use the 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?

# 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

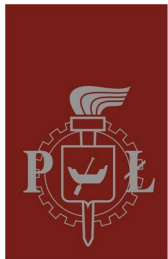
# *MaZda 4.5 Tutorials*

## MaZda plugins



June 2006

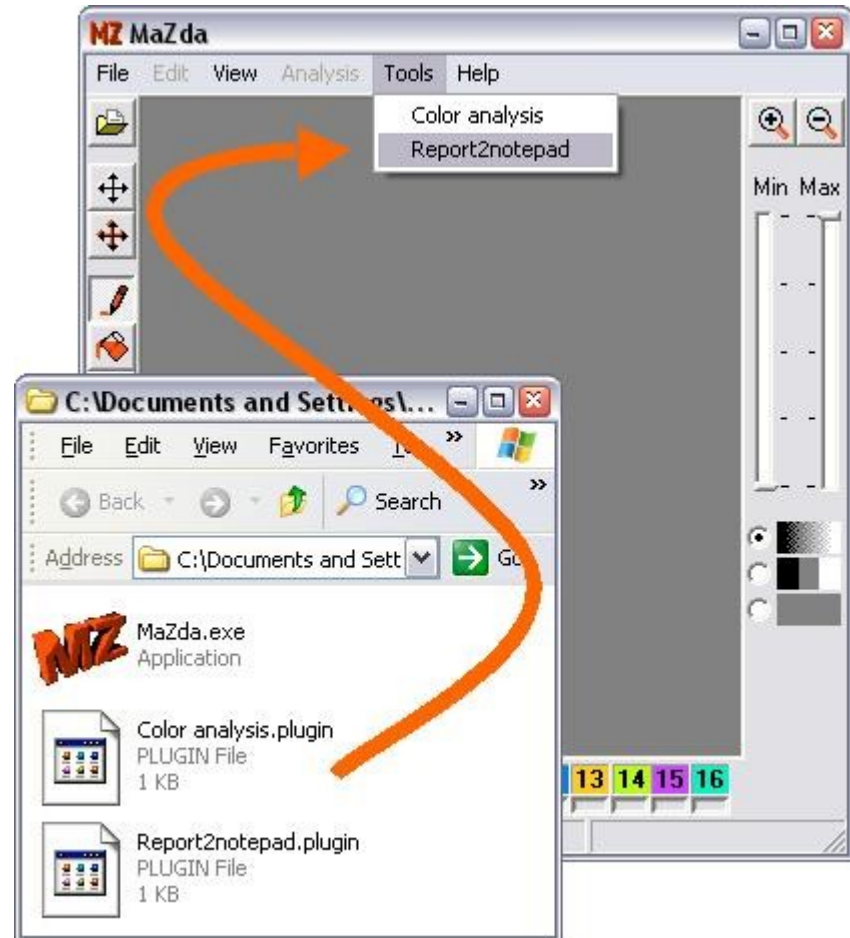
Piotr M. Szczypiński



Technical University of Lodz  
Institute of Electronics

# Plugins

Plugins are implemented in **MaZda** through its macro technology. Macro files given a “.plugin” extension, located in MaZda’s working directory are recognized as plugins, and are accessible from the MaZda **Tools** menu.



# MaZda macro instructions

**LoadImage** *file\_path\_and\_name* – loads an image for analysis from a given file,  
**LoadROI** *file\_path\_and\_name* – loads regions of interest from a given file,  
**LoadOptions** *file\_path\_and\_name* – loads options from a given file,  
**LoadReport** *file\_path\_and\_name* – loads a report into the report window,  
**ColorChannel** [*arg = Y, R, G, B, U, V, H or S*] – selection of color conversion mode,  
**ReloadImage** – reloading an opened image (e.g. after changing a color conversion mode),  
**RunAnalysis** – starts the analysis process,  
**Execute** *file\_path\_and\_name argument\_list* – executes program from a given file,  
**AggregateReports** – joins data from two reports,  
**SaveImage** – saves an opened image,  
**SaveSelected** *file\_path\_and\_name* – saves selected features to a given file,  
**SaveReport** *file\_path\_and\_name* – saves report from opened tab-page of report window to a given file,  
**SaveMap** *file\_path\_and\_name* – saves feature map from opened tab-page to a given file,  
**CloseReport** – closes opened tab-page of report window,  
**CloseMap** – closes opened tab-page of feature map,  
**Exit** – unconditional MaZda termination.

Any line starting with '/' or ';' is a comment, which is ignored by the interpreter

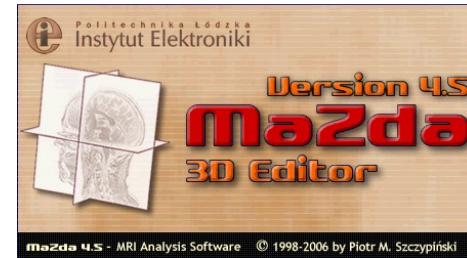
# Exercise 1

1. With a *notepad* editor open a file *Report2notepad.plugin* located in *MaZda* folder
2. What is a purpose of this plugin?
3. Start *MaZda* and load any report to the *Report* window
4. Now, run the *Report2notepad* plugin (*Tools* → *Report2notepad*)
5. Write a plugin that will save currently opened image into a *temp.bmp* file and then will open it with *mspaint.exe* program



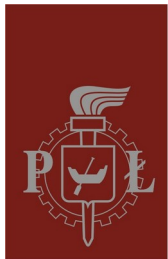
# *MaZda 4.5 Tutorials*

## Feature maps



June 2006

Piotr M. Szczypiński



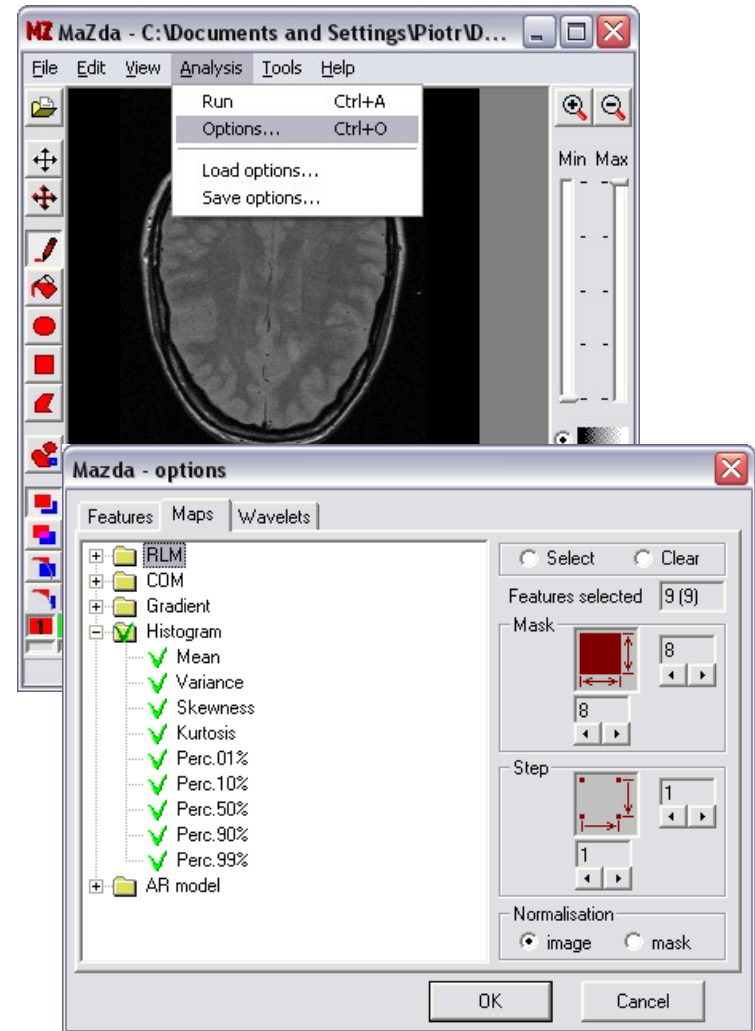
Technical University of Lodz  
Institute of Electronics

# Maps computation

**MaZda** allows also for maps computation, which are texture parameters computed in a small window sliding over the image surface. The maps computation is basically a form of image nonlinear filtration.

To compute maps:

1. Open *Options* dialog box (Analysis → Options) and select *Maps* tab-page
2. Indicate an element in the tree diagram and then click a "select" or "clear" button to, respectively, select or unselect features for maps generation
3. Run the image analysis (Analysis → Run)
4. When the analysis completes the Image view window appears and the resulting maps are presented

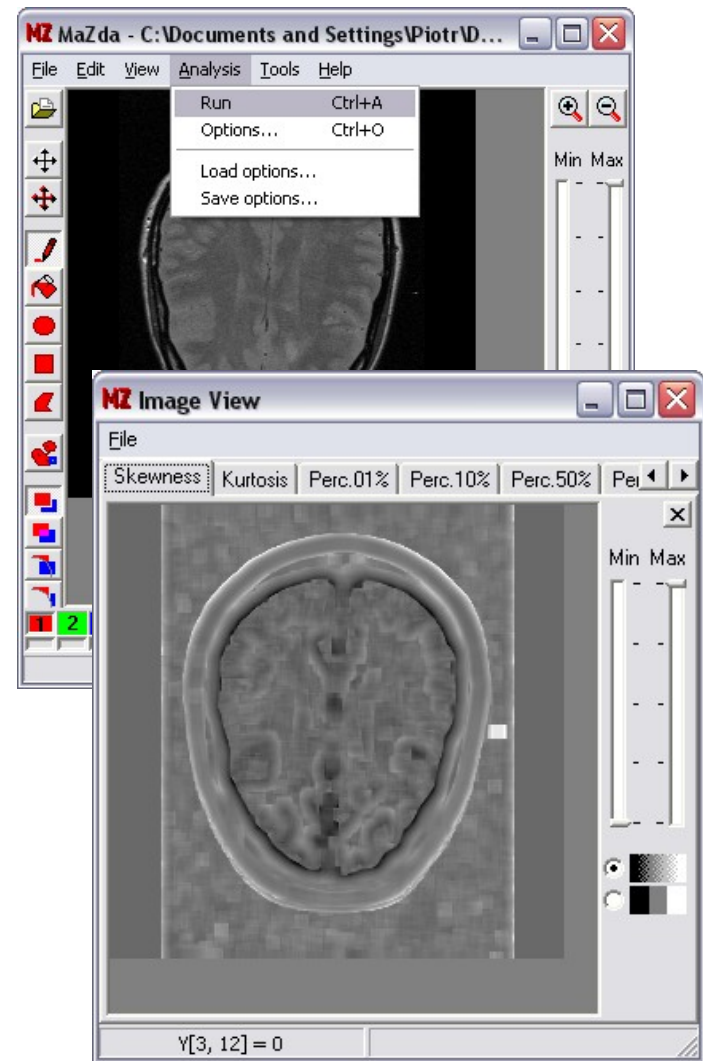


# Maps computation

**MaZda** allows also for maps computation, which are texture parameters computed in a small window sliding over the image surface. The maps computation is basically a form of image nonlinear filtration.

To compute maps:

1. Open *Options* dialog box (Analysis → Options) and select *Maps* tab-page
2. Indicate an element in the tree diagram and then click a "select" or "clear" button to, respectively, select or unselect features for maps generation
3. Run the image analysis (Analysis → Run)
4. When the analysis completes the Image view window appears and the resulting maps are presented



# Exercise 1

- Start MaZda
- Load image *mazdatex.bmp* from *Tutorials\6\_Feature\_maps* folder
- What does this image present?
- Set analysis options for computation of histogram maps, set normalization to *image*.
- Run the analysis
- The Image view window will appear
- Switch the image view tab-page to Perc.10% map
- What does this image present?