

## A small tutorial about free software to process 3D images and meshes

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### Reading 3D medical images

In general, 3D medical images (CT-Scan, MRI) are in a standard format called DICOM (*Digital Imaging and Communications in Medicine*<sup>1</sup>).

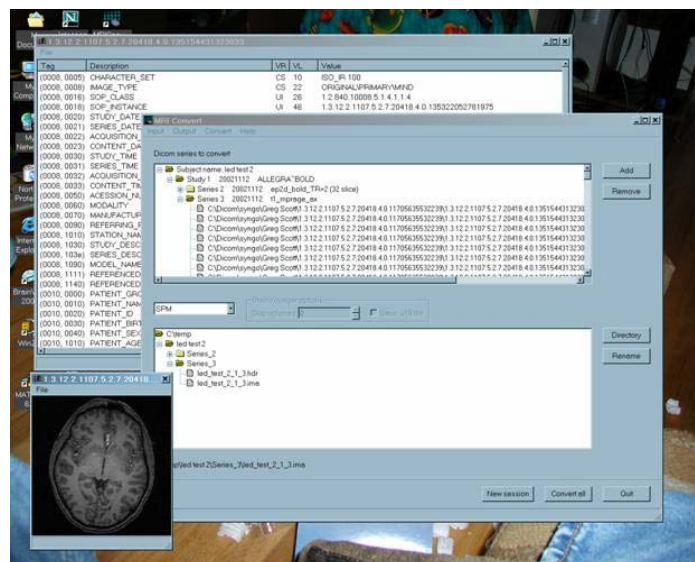
This format is quite complex and includes many information about the patient and the acquisition process. For image processing purposes, it is more convenient to convert DICOM files into a very simple and standard format which includes only data about the image.

We propose to use the Analyze 7.5 format<sup>2</sup>. The image is then composed of 2 files:

- The header (.hdr) which contains the image size and the resolution of the voxel. More information may be added.
- The content of the image (.img) which is coded as the list of the intensities (a value which is in general between 0 and 65535 and which is coded on 2 bytes) of all the voxels.

### How to convert DICOM data into Analyze 7.5 format?

You may use the MRIConvert software<sup>3</sup> which is free and runs on Windows and Linux OS. This software is regularly updated.



1. Define the folder where is the DICOM series by *Input/Add Folder*
2. All the files of the folder will be analyzed. Validate by *Okay*.
3. Select *Analyse 7.5* in the format window in the middle.
4. Select the folder to output the result file by *Directory*.
5. Click on *Convert all*

<sup>1</sup> <http://en.wikipedia.org/wiki/DICOM>

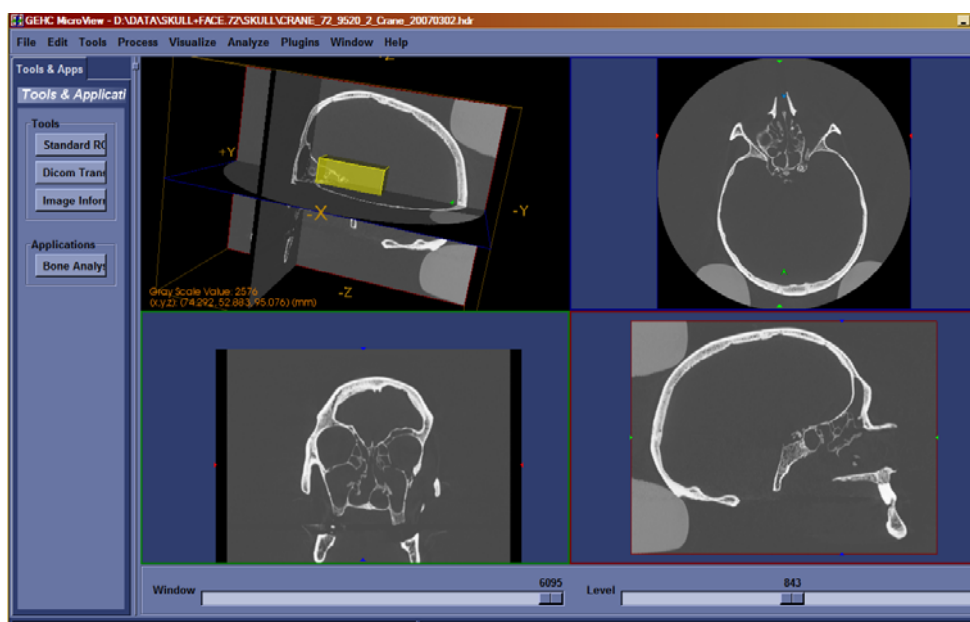
<sup>2</sup> <http://www.mayo.edu/bir/PDF/ANALYZE75.pdf>

<sup>3</sup> <http://lcn.uoregon.edu/~jolinda/MRIConvert/>

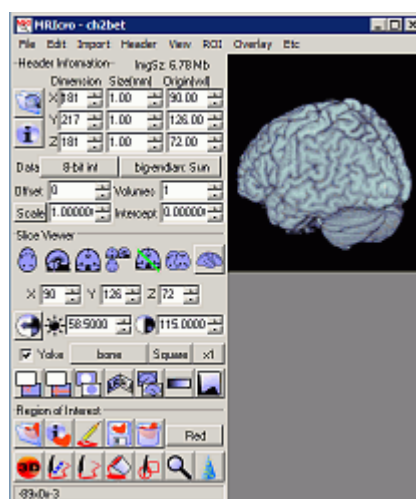
### How to visualize Analyze 7.5 files?

A very good software is **MicroView**<sup>4</sup> (v. 2.0.29) which is free and runs on Windows (and maybe Linux) OS. This software which was developed by General Electric Healthcare seems to be no more updated. Nevertheless, it proposes a lot of interesting functionalities as 3D visualization and resampling. It reads Analyze files. A more recent version is available<sup>5</sup> (v. 2.1.2) but it seems that there are some problems to read Analyze files.

A user guide is also available<sup>6</sup>.



You may also use **MRicro**<sup>7</sup> software which is free and runs on Windows or Linux OS. This software is dedicated to medical image processing and is regularly updated.



<sup>4</sup> [http://www.gehealthcare.com/usen\\_fun\\_img/pcimaging/products/microview.html](http://www.gehealthcare.com/usen_fun_img/pcimaging/products/microview.html)

<sup>5</sup> <http://microview.sourceforge.net/>

<sup>6</sup> <http://www.oucom.ohiou.edu/ou%2DmicroCT/Downloads/MicroView.pdf>

<sup>7</sup> <http://www.sph.sc.edu/cmd/rorden/>

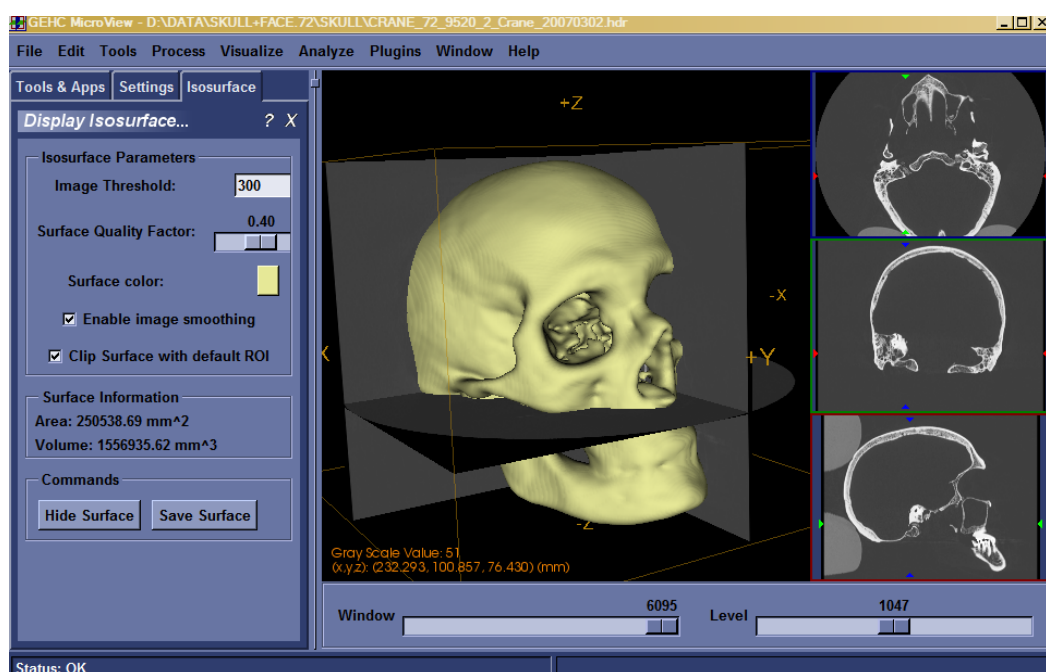
Other visualization software can be found on the Web site [idoimaging.com](http://idoimaging.com)<sup>8</sup>.

## Extracting 3D surfaces from 3D images

### Computing isosurfaces

MicroView allows extracting an isosurface from the 3D image by *Visualize/Isosurface*.

An isosurface is the surface that through all the voxels (volume elements) of a 3D image which have a given intensity or density. For example, in a CT-Scan image, if you select an intensity around 300 to 500 HU (see Figure below) which separates the air (some tens Hs) and the bone (superior to 1000 HU), you will be able to extract the 3D surface of the bony parts.



You can save the surface as a list of triangles. We propose to use the STL format<sup>9</sup> which is standardized and widely used.

The Surface Quality Factor will define how many triangles will be used to build the isosurface. A good value is around 0.40. Surfaces with more than 500,000 triangles are quite complex to handle by 3D surface visualization and processing software. With more than 1 to 1.5 million triangles, it becomes quite impossible on standard computers.

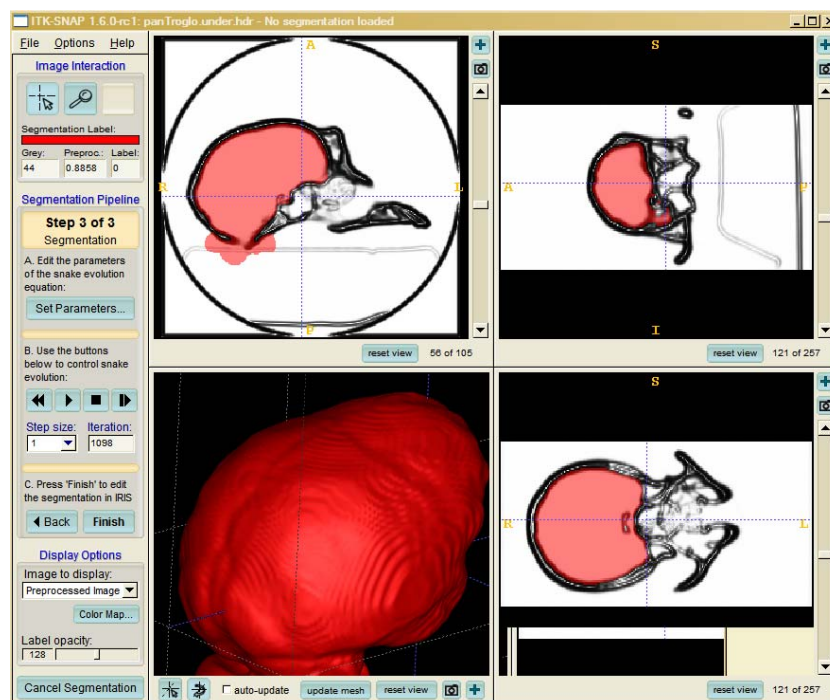
### The problem of segmentation

More generally, we call "segmentation" the process of delineating the 3D contours of the structure you want to study. The segmentation method depends on the structure, the image type or quality, the required resolution or the available time. The simplest way is to perform manual segmentation. In this case, the user (with some expertise) uses a kind of paintbrush tool to color on the screen the voxels of the structure. It is a very tedious work when you have several tens or hundreds slices to process. So, many algorithms have been proposed since a decade in order to (semi)-automatize segmentation. As the segmentation efficiency depends on the application, we cannot find a generic tool. Nevertheless, if we want to test manual segmentation and a class of automatic method called

<sup>8</sup> <http://www.idoimaging.com/index.shtml>

<sup>9</sup> [http://en.wikipedia.org/wiki/STL\\_\(file\\_format\)](http://en.wikipedia.org/wiki/STL_(file_format))

“Deformable models”, one can install and test ITK-Snap<sup>10</sup>. This software does not work when the images are too large (more than 300 slices of 256x256 pixels). A good tutorial is available in the “Help” menu.



### How to visualize and process 3D surface files?

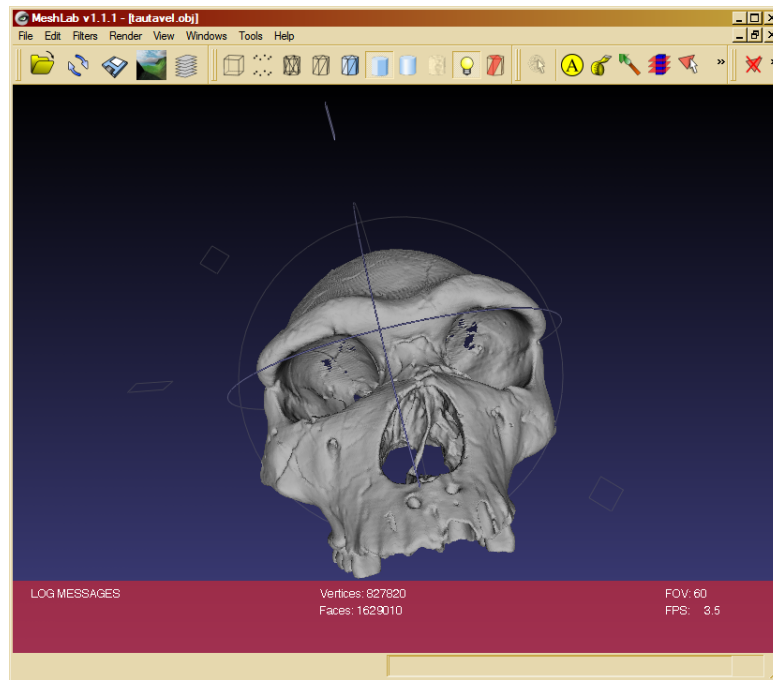
A very good software to visualize and process 3D surfaces composed of triangles is MeshLab<sup>11</sup> which is free, runs on Windows, Linux and MacOSX OS and is regularly updated. In particular, it reads STL files.

Among the functionalities, we can cite:

- Conversion to many formats (as OBJ, PLY),
- Basic processing: smoothing, filtering (as removing duplicated vertices),
- Decimating the mesh in the Filters menu, i.e. diminishing the number of faces while keeping the shape,
- Measuring tool (distance),
- Cutting parts in the surface. For this purpose, select the “green brush” / “selecting & editing”. You can then select triangles which should appear colored in pink. Beware that sometimes, the brush colorizes nothing but the triangles are selected. When you click on “backfaces”, the triangles which are seen backwards are also selected. When you click on the “crossed triangle with circles”, all the selected triangles are deleted. Notice that you can use Filters / Select / Invert Selection to select the complimentary triangles. This functionality is very useful to segment sub-parts of the mesh.

<sup>10</sup> <http://www.itksnap.org>

<sup>11</sup> <http://meshlab.sourceforge.net/>



- Aligning two meshes. You should load at least two meshes, the first one by "File / Open" and the others by "File / Open inside". All the meshes are in the same frame. Select the "circled A". The list of meshes is displayed. Select the reference mesh (i.e. the one which will not move) by "Glue mesh here". Select another mesh and click on "Point Based Glueing" which launches the manual alignment procedure. It consists in clicking corresponding points (at least 4) on the reference and the other meshes. Click on "Allow Scaling" if you want to add the possibility of uniform scaling. When you click on "OK", the best composition of rotation, translation and eventually scaling is computed and the other mesh is aligned on the reference one. If you click after on "Proceed", an automatic procedure will refine the alignment.