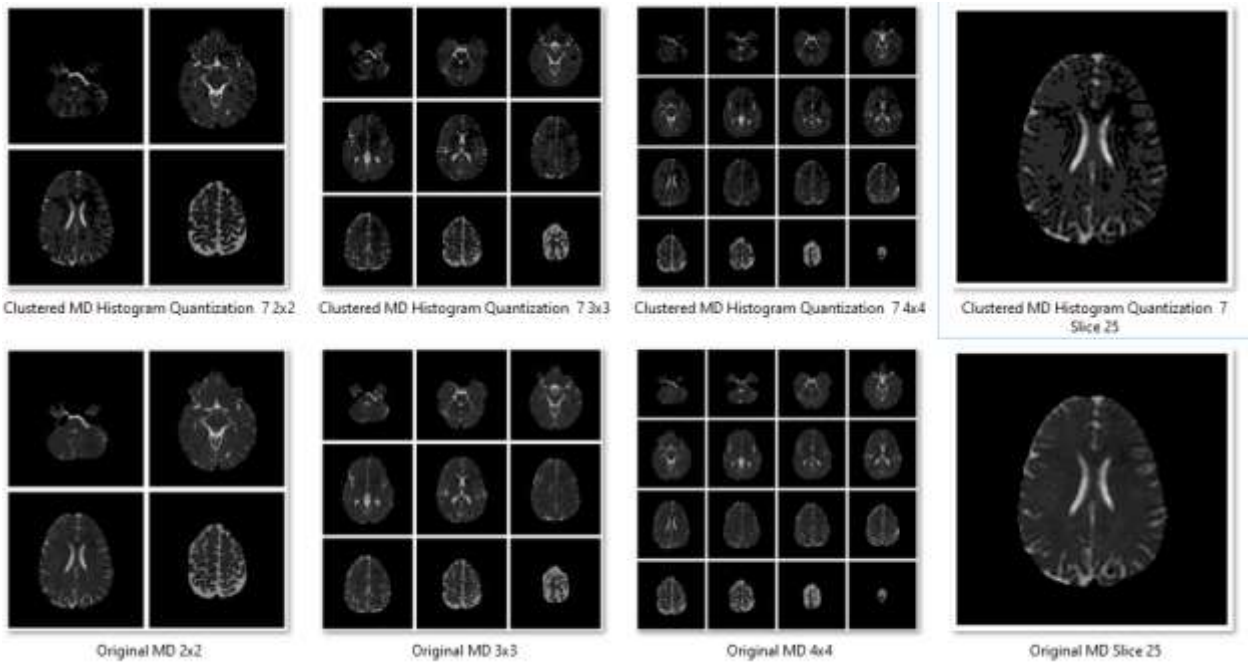
Medical Images Segmentation Utility

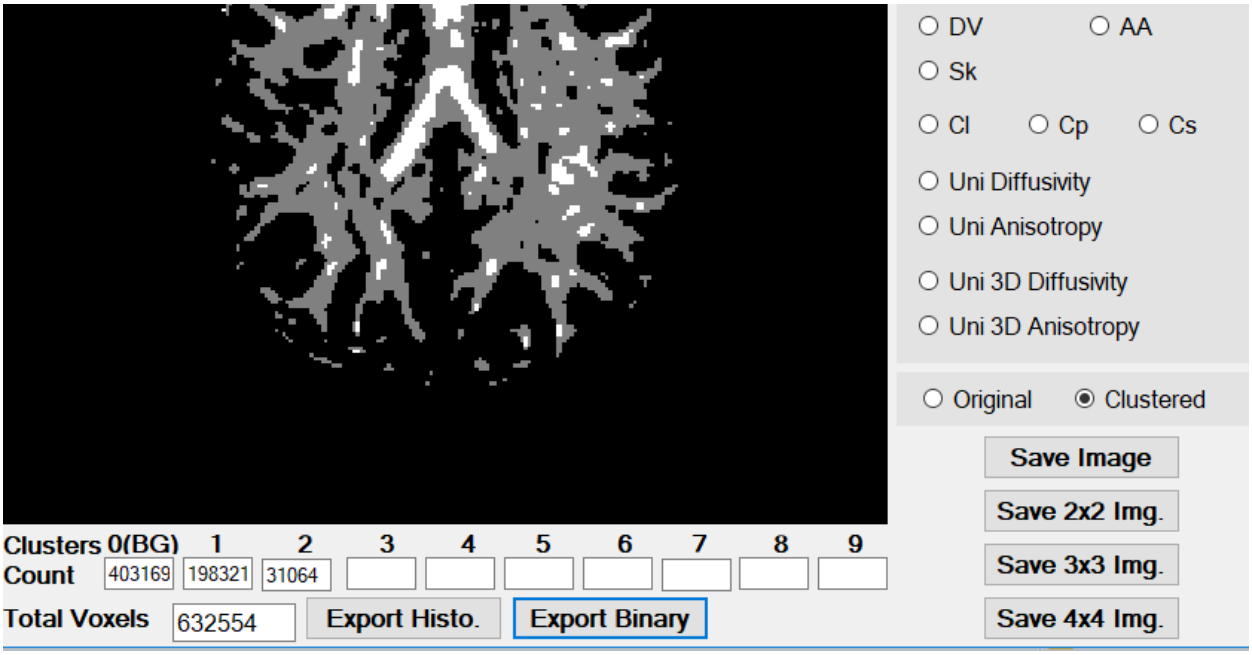
(MISU)

Developed by: Ihab ELAFF (2025)

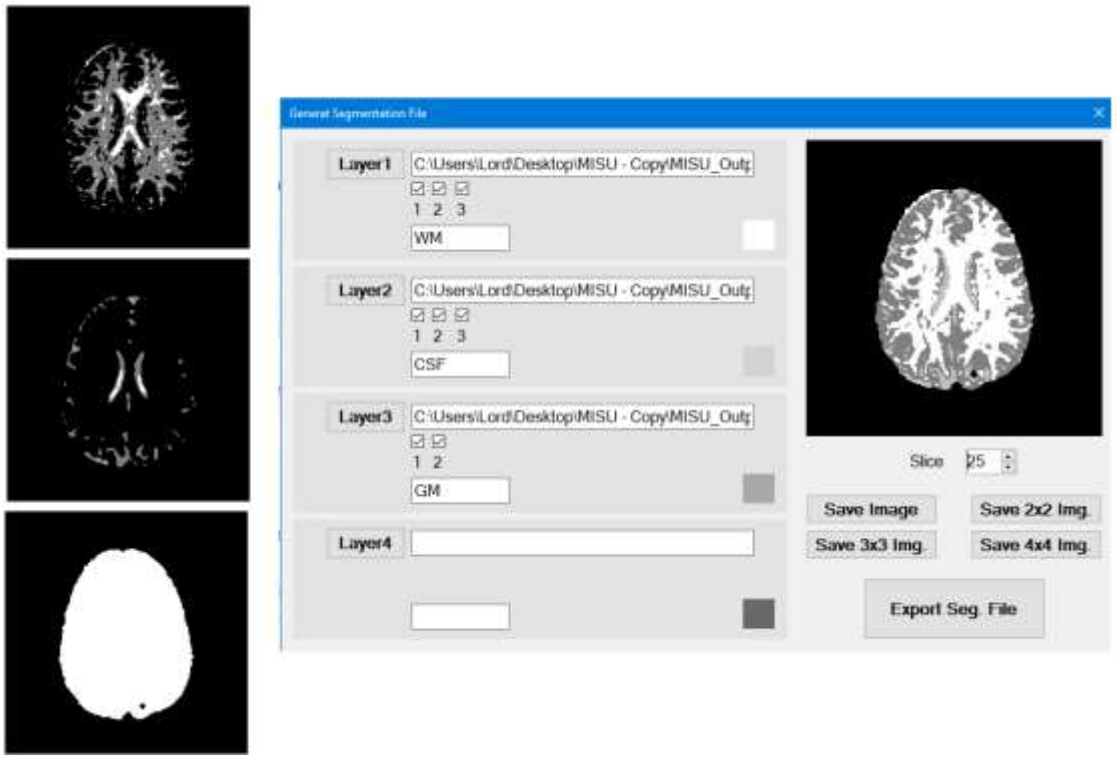
- Works with most medical imaging modality: DTI, MRI, X-Ray, CT, FLAIR, PET and MRA
- Export formatted results at a click of a button



- Export useful statistics (histogram) to Excel file

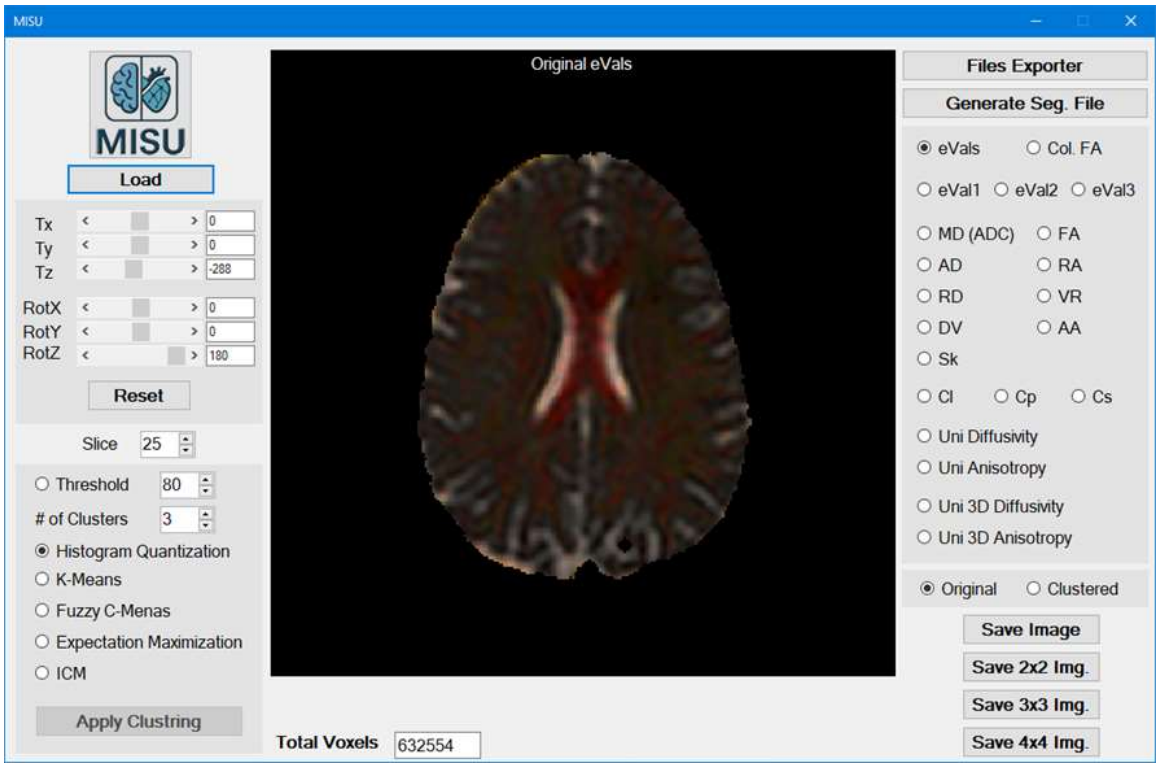


- Combine suitable clusters together to generate the Segmentation Map



The program has 3 main functions, Image Clustering Utility, Image Segmentation Utility and File Exporter

1 – Image Clustering Utility:



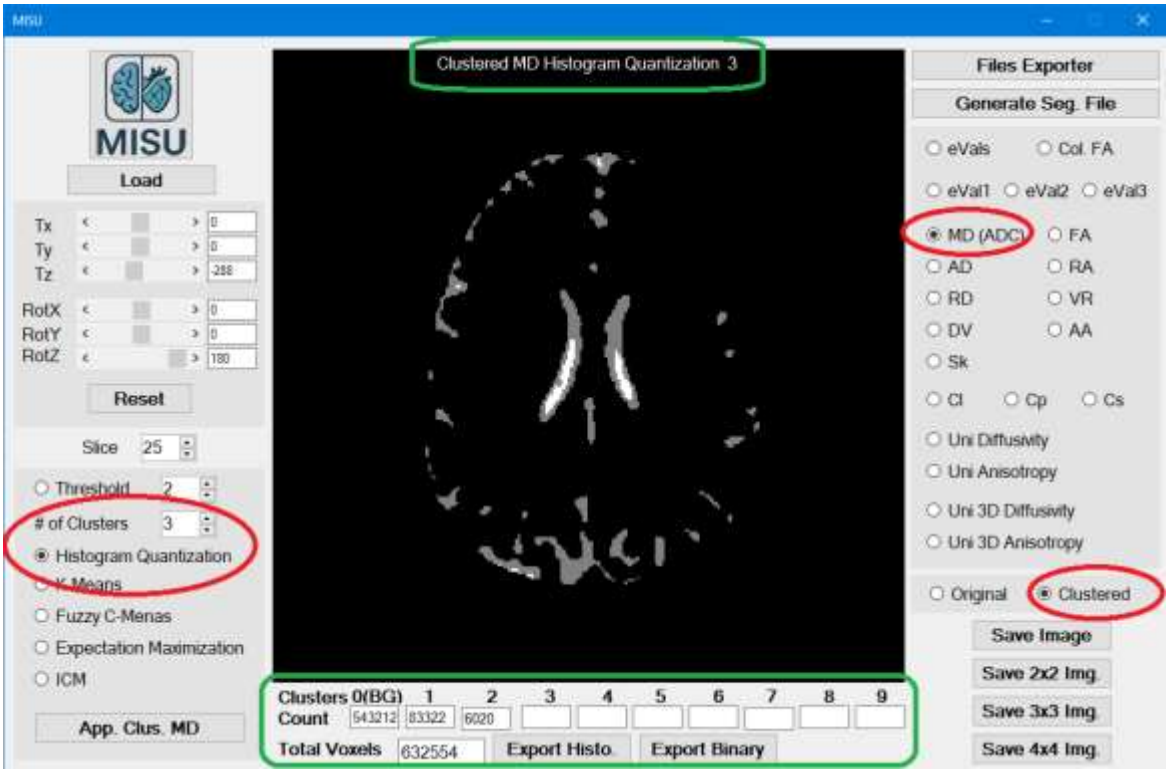
Loading the File: Image Clustering Utility is the main form of the application. Just load MISU file or any Image files (BMP, PNG, JPG) and then you are ready to go.

> **When loading MISU file:** For DTI modality, all Scalar Indices (SI) + Unistable and Unistable 3D are included, however for other modalities (MRI, CT, Flair … etc.) only magnitude, Unistable and Unistable 3D would be available.
>
> **When loading Image file:** Only magnitude will be available.

Clustering Algorithms: According to the selected image, Clustering algorithm can be applied. You can select simple threshold clustering or use one of the following clustering algorithms:

- Histogram Quantization
- K-Means
- Fuzzy C-Means (FCM)
- Expectation Maximization (EM)
- Iterated Conditional Mode (ICM)

Just specify the algorithm and the required number of clusters and click the button.

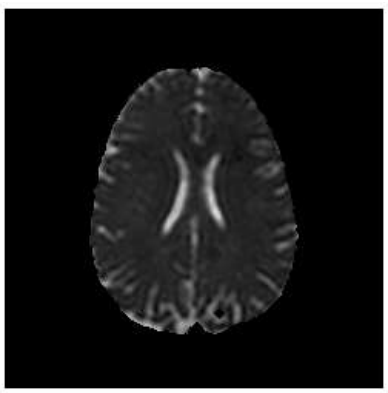


You can switch between the original image view and the clustered image view. In the clustered image view, **the detailed title of the image** is displayed at the top of the image and counting of each cluster is displayed at the bottom of the image.

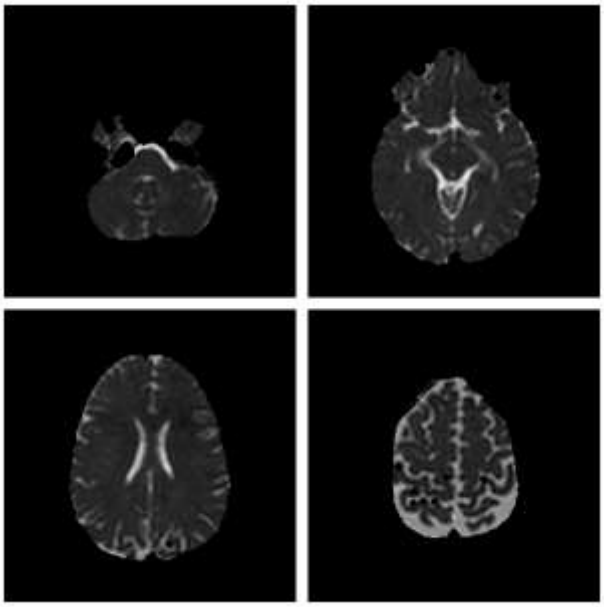
Export Histogram (Clustered Image): Will export those statistics to CSV file (to be used by Excel)

Export Binary (Clustered Image): Will export the binary file of the segmentation, where the .BIN file will be used in the segmentation process.

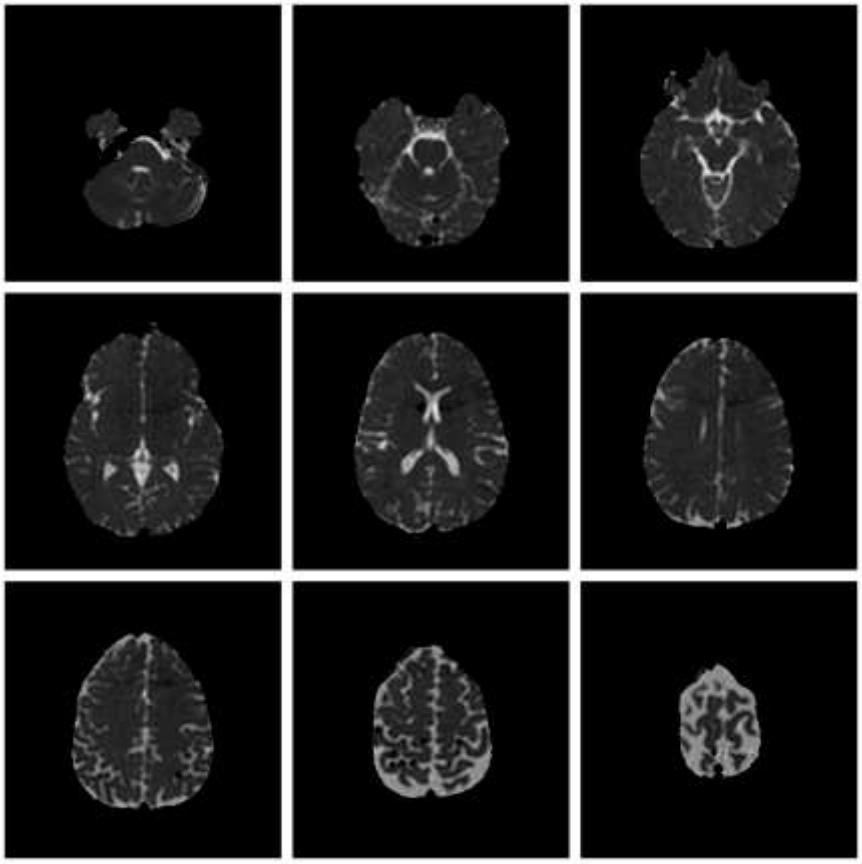
Save Image (Original Image / Clustered Image): Save only the current image to a PNG file. The name of the file will be **the detailed title of the image**.



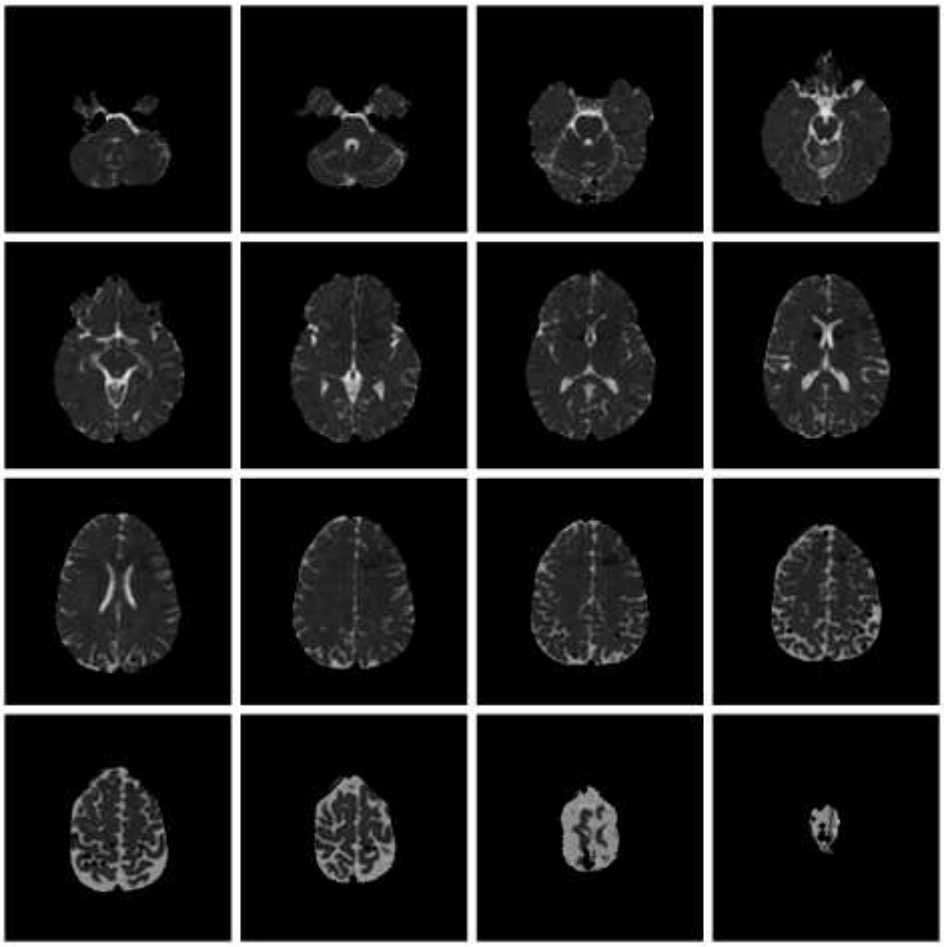
Save Image 2x2 (Original Image / Clustered Image): Save 4 slices of the scan to a PNG file. The name of the file will be **the detailed title of the image 2x2**.



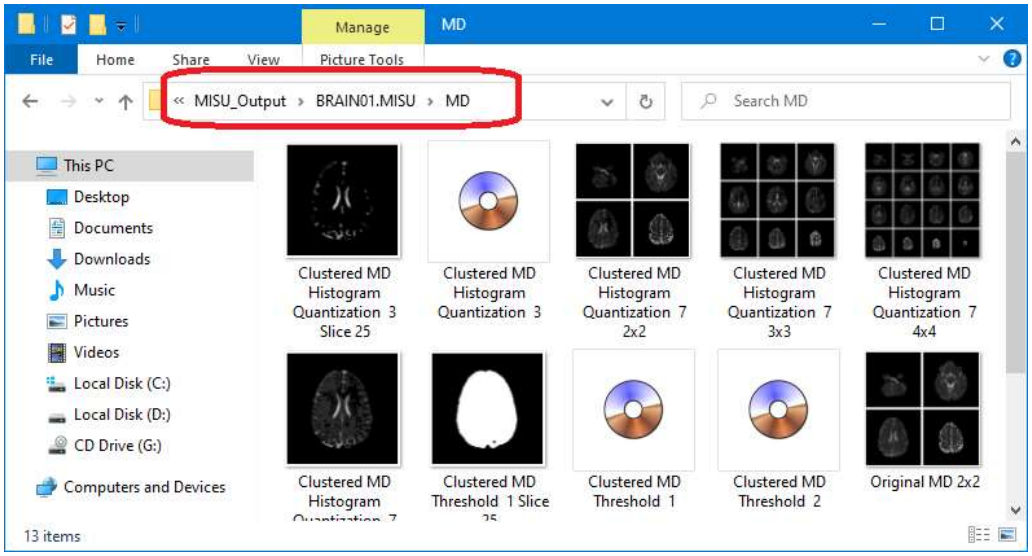
Save Image 3x3 (Original Image / Clustered Image): Save 9 slices of the scan to a PNG file. The name of the file will be **the detailed title of the image 3x3**.



Save Image 4x4 (Original Image / Clustered Image): Save 16 slices of the scan to a PNG file. The name of the file will be **the detailed title of the image 4x4**.



P.S: All files will be saved on the folder **"MISU_Output"** inside a sub-folder with the **MISU file name**



2 - Image Segmentation Utility

After exporting the suitable Binary files, you can customize which clusters will be included to represent the tissue.

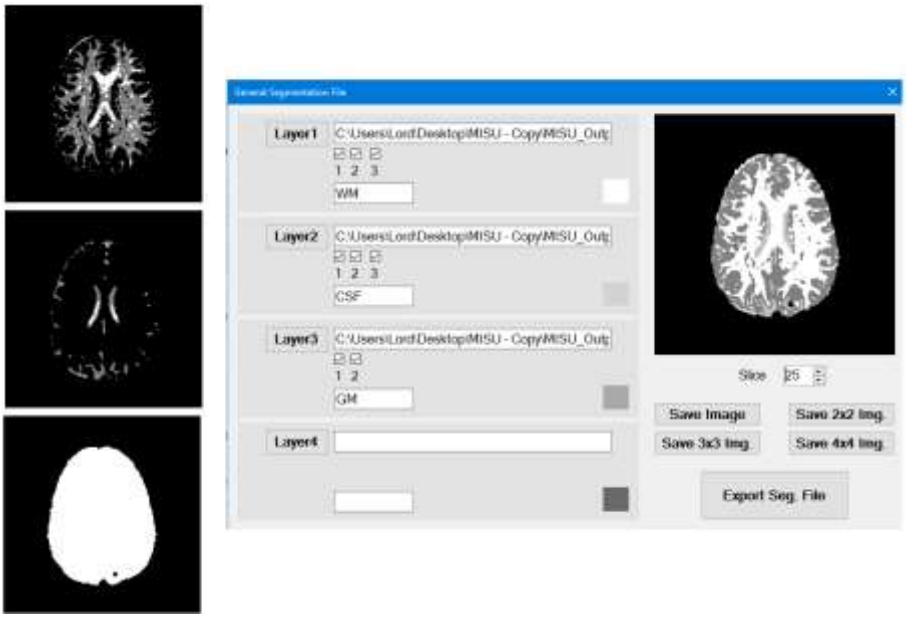
Example How to build Brain's WM, GM and CSF:

In the Clustering Utility do the following:

- Generate the WM/non-WM file: Select FA, apply Histogram Quantization with 3 clusters, and save the binary file of the clustered image.
- Generate the CSF/non-CSF file: Select MD, apply Histogram Quantization with 3 clusters, and save the binary file of the clustered image.
- Generate the entire tissues file (GM is non-WM and non-CSF): Select MD, apply Threshold clustering with value 2, and save the binary file of the threshold image.

In the Segmentation Utility do the following:

- Load WM/non-WM file as Layer 1 (Top Layer), CSF/non-CSF file as Layer 2 and the entire tissues file as layer 3.
- Once you unselect one of the clusters check boxes, the cluster will not be included in the layer and its space will be available for the other lower layers.



Once again, **"Images Export" buttons** are available with the same manner as the clustering utility. You can export the segmentation file for further modeling (**Brain or heart excitation propagation utility and Tumor growth simulation utility which will be soon available on GitHub**).

3 - File Exporter

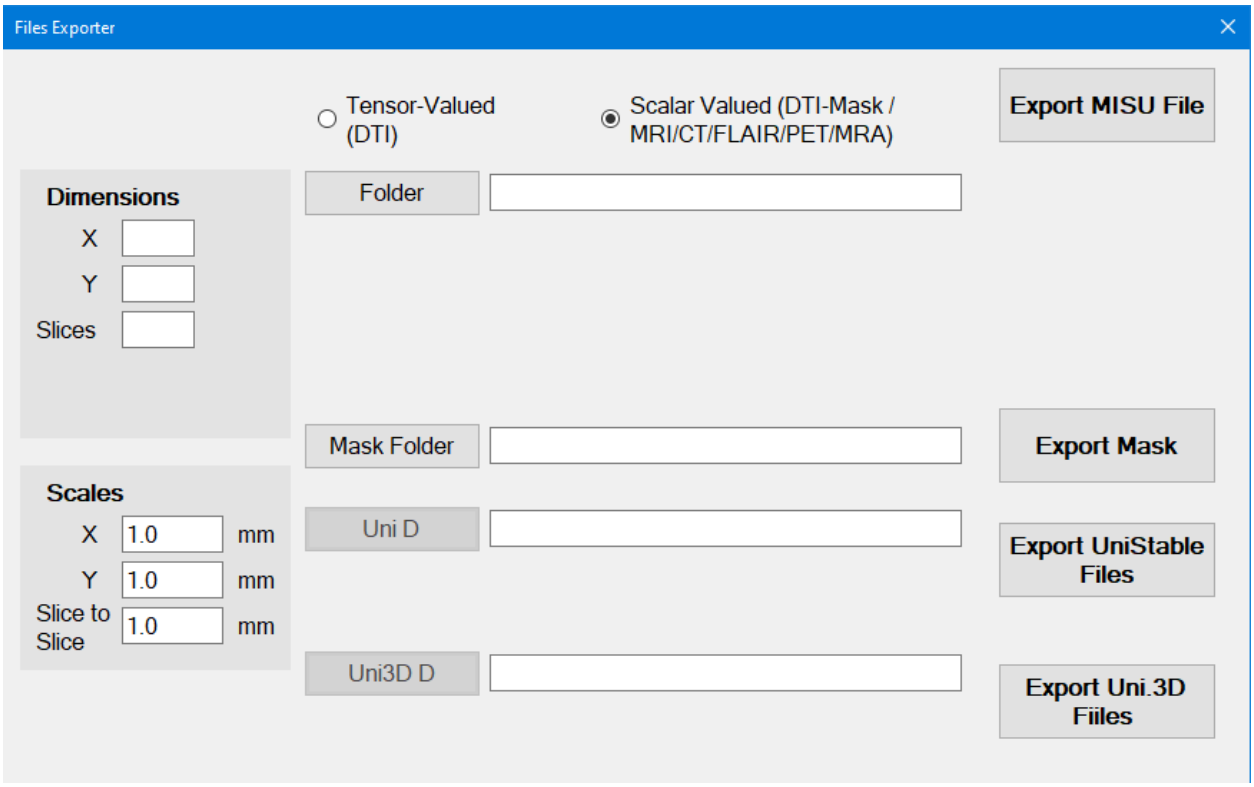
You can generate the following using this utility:

- The MISU file
- Unistable File(s)
- Unistable 3D File(s)
- The Mask file of the MISU file (based on manual removal of undesired tissues)

Sample Brain file is included in the program folder "MISU_Input"

For Tensor-Valued scans (DTI):

- Used MRI Studio Software (https://www.mristudio.org/) to export eigenvector and eigenvalue data that derived from diffusion tensor imaging (DTI) as raw binary files.
    - eigenvalue files are (e1, e2, and e3)
    - eigenvector files are (ev1, ev2, and ev3)
- eVec1, Mask Uni D, Uni A, Uni3d D and Uni3D A are optional (but also recommended)
- **Dimensions** and **Scales** SHOULD be specified by the user as eigenvalue files (which are exported by DTI Studio) contains raw data
- Once you specify eVal1, eVal2 and eVal3, you can export the Unistable and Unistable 3D files.
- **The Mask** can be generated by the Scalar-Valued scans option first and then it can be used here.



For Scalar-Valued scans (MRI/CT/FLAIR/PET/MRA/X-Ray):

- The files should be stored as image files (BMP, PNG or JPG)
- The order of the Slices of the scan depends on the order of the image files Name.
- You Select the folder that contains the images and everything will be done automatically.
- Dimensions will be detected automatically but the Scales are still required to be entered by the user.

About MISU

- MISU (Medical Image Segmentation Utility) is developed using SharpDevelop under the GNU General Public License.
- It uses OpenTK for graphics rendering and visualization.

License

This project is licensed under the MIT License for **academic and educational use only**.

Acknowledgments

- SharpDevelop– IDE used for development (GNU GPL).
- OpenTK– Open Toolkit Library for OpenGL graphics.
- MRI Studio– For dataset samples and diffusion imaging tools.

Citation

If you use MISU software in your research, you must cite the following and add the utlity URL:

[1] ELAFF I, EL-KEMANY A, and KHOLIF M "Universal and stable medical image generation for tissue segmentation (The unistable method)," Turkish Journal of Electrical Engineering and Computer Sciences: Vol. 25: No. 2, Article 32, 2017. https://doi.org/10.3906/elk-1509-100

[2] Elaff I, "Medical Image Enhancement Based on Volumetric Tissue Segmentation Fusion (Uni-Stable 3D Method)", Journal of Science, Technology and Engineering Research, vol. 4, no. 2, pp. 78–89, 2023. https://doi.org/10.53525/jster.1250050.

[3] Elaff I "Brain Tissue Classification Based on Diffusion Tensor Imaging: A Comparative Study Between Some Clustering Algorithms and Their Effect on Different Diffusion Tensor Imaging Scalar Indices". Iran J Radiol. 2016 Feb 28;13(2):e23726. https://doi.org/10.5812/iranjradiol.23726

[4] El-Aff I "Human brain tissues segmentation based on DTI data," 2012 11th International Conference on Information Science, Signal Processing and their Applications (ISSPA), Montreal, QC, Canada, 2012, pp. 876-881, https://doi.org/10.1109/ISSPA.2012.6310677