

Toolbox for Automated Ischemic Lesion Segmentation in MRI Mouse Brain Data after Transient Middle Cerebral Artery Occlusion

Introduction

This toolbox implements our method for segmenting the stroke area from MRI mouse brain data. Complete description of our method is presented in our publication [1]. The toolbox was implemented in Matlab R2012b and tested on Matlab R2015a. It consists of the main segmentation routine *mouseStrokeSegmentation.m* and several auxiliary routines (p-coded Matlab files and dynamic libraries).

Usage

Before executing the software, it is necessary to:

- Add the root folder of the toolbox and the auxiliary *Routines* folder to the Matlab path.
- Download registration software *elastix* from <http://elastix.isi.uu.nl/download.php>.
- Update in the main file *mouseStrokeSegmentation.m* the value of the *elastixdir* variable that points to the folder where *elastix* is installed.

Our file naming agreement assumes that each data set to be processed is named according to the following convention [2,3]: *[scanName][scanType].(mhd/raw)*, e.g.:

- *MouseBrain1_24h_T2map.(mhd/raw)*
- *MouseBrain1_24h_echoe1.(mhd/raw)*, *MouseBrain1_24h_echoe2.(mhd/raw)*, ...

The software takes following inputs:

- *datadir*: string pointing to the folder in which the acquired T2-maps (in meta-volume format) are located. The T2- maps will be used for performing the segmentations (except for refining the *whole-brain* label; see [1] for the detailed description) and , in case the echoes are not provided as input, for the registration with the label propagation and for refining the *whole-brain* label.
- *echodir*: string pointing to the folder in which all the acquired echoes (in meta-volume format) are located. This parameter is optional: in case not specified, the corresponding T2 map will be used for the registration with the label propagation and for refining the segmentation of the whole brain. However, for optimal segmentation performance we recommend using the echo images as well.
- *params*: vector of segmentation parameters. This parameter is optional: in case (some of the entries are) not specified, the default values will be used. The following table provides meaning of each entry of the parameters vector and its default value; see also [1].

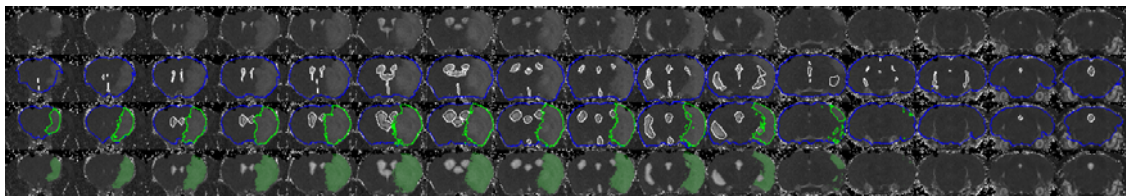
	Whole brain		Contralateral ventricle		Ventricles		Stroke	
α	#1	5	#4	0.1	#7	2	#10	0.3
μ	#2	2	#5	0	#8	1.5	#11	0
n_{iter}	#3	80	#6	120	#9	120	#12	80

- *lbdir*: string pointing to the folder where results of label propagation (calculated during previous run of the software) are stored. This parameter is optional: in case not specified, the labels will be calculated using the labelled atlas.
- *resdir*: string pointing to the folder in which the results will be saved. This parameter is optional: in case not specified, the default location (*Results* subfolder) will be used. Results of each run are stored in the newly created results folder with a timestamp in the name.

Examples: `mouseStrokeSegmentation('C:\MyData\T2maps')`
`mouseStrokeSegmentation('C:\MyData\T2maps', 'C:\MyData\Echoes')`
`mouseStrokeSegmentation('C:\MyData\T2maps', 'C:\MyData\Echoes', [5; 2; 2; 0.1; 0; 3; 2; 1.5; 3; 0.3; 0; 2])`
`mouseStrokeSegmentation('C:\MyData\T2maps', 'C:\MyData\Echoes', [5; 2; 2; 0.1; 0; 3], 'C:\MyData\Labels')`
`mouseStrokeSegmentation('C:\MyData\T2maps', 'C:\MyData\Echoes', [], 'C:\MyData\Labels')`

The software saves the calculated volumes of the stroke region in the `_measurements.txt` file and also produces two types of image results:

- Tiled images with superimposed segmentation results; see figure below for an example. The first row of each of these figures represents the original T2-map cropped to the brain region; the second row illustrates the *whole-brain* and *ventricles* labels, obtained as result of label propagation, overlaid over the T2-map; and the last two rows show the segmentation results, as boundaries (third row) or masks (fourth row), overlaid over the T2-map.



- Meta-volumes of segmented structures: whole brain, ventricles, and stroke region. These files are stored in the *Volumes* subfolder of the results folder.

In addition, results of label propagation are stored in the *Labels* folder (only if the *lbldir* input variable was not provided or was left empty) and can be used as an input for the subsequent runs (e.g. with a different set of parameters).

As part of this toolbox, we also provide a template that includes MRI data (T2-map, sum of 20 echoes) and four manually-drawn labels and the corresponding registration parameter files [1,2]. For creating the template, a scan of a mouse belonging to the 3- to 5-month-old mice age group, 24 h after stroke onset was used. Several anatomical structures were manually segmented on the acquired data to be propagated to each data set during the registration step. Please notice that, even though our template is quite representative and we were able to obtain results of reasonable quality when using it on data acquired on different hardware and/or software, we recommend creating a targeted template for each group of scans based on acquisition hard- and software, mouse strain, etc. This might also require adjustment of the registration parameters.

Terms and conditions

The toolbox made available here is free for download under the following conditions:

- It may be used for research purposes only
- It is for personal use only, and may not be redistributed
- In no event shall the LUMC be liable for any direct or indirect damage, arising in any way out of the use of this toolbox
- Any publication arising from the use of this toolbox and/or dataset should cite references [1] and [2].

References

1. Mulder IA, Khmelinskii A, Dzyubachyk O, de Jong S, Rieff N, Wermer MJH, Hoehn M, Lelieveldt BPF and van den Maagdenberg AMJM (2017) **Automated ischemic lesion segmentation in MRI mouse brain data after transient middle cerebral artery occlusion**, *Frontiers in Neuroinformatics* 11:3, <http://dx.doi.org/10.3389/fninf.2017.00003>
2. Mulder IA, Khmelinskii A, Dzyubachyk O, de Jong S, Wermer MJH, Hoehn M, Lelieveldt BPF and van den Maagdenberg AMJM (2017) **MRI mouse brain data of ischemic lesion after transient middle cerebral artery occlusion**, *Frontiers in Neuroinformatics*, 2017
3. Mulder IA, Khmelinskii A, Dzyubachyk O, de Jong S, Wermer MJH, Hoehn M, Lelieveldt BPF and van den Maagdenberg AMJM (2017) **Data from: MRI mouse brain data of ischemic lesion after transient middle cerebral artery occlusion**, Dryad Digital Repository. <http://dx.doi.org/10.5061/dryad.1m528>

Download

This toolbox can be downloaded from the Software Downloads section of our webpage: www.lkeb.nl

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