LESION DETECTION USING T1-WEIGHTED MRI: A NEW APPROACH BASED ON FUNCTIONAL CORTICAL ROIS

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ICIP 2017
IEEE International Conference on Image Processing
September 17-20, 2017, Beijing, China

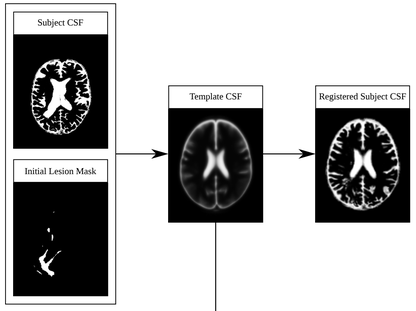
Motivations

- Accurate and precise detection of brain lesions on MR images is important for relating lesion locations to impaired behaviors.
- Concerning the additional time and cost in acquiring multi-modal images, only T1-weighted MRIs are used for lesion detection.
- Lesion detection is challenging due to (1) the intensity similarity between lesions and surrounding healthy tissues, (2) large variation of lesion size, shape and location, and (3) possible deformation of brain.

Proposed Methodology

- In contrast to existing automatic lesion detection methods typically detect lesion voxels on the whole image using single classifier, we show that training multiple classifiers regarding the functional cortical ROI can lead to better performance.
- ***Image Processing***
  - The initial lesion mask is generated by comparing the probability maps of GM and WM against the template.
  - The initial ROI registration is achieved by imposing the predefined ROI onto the registered image using proposed cerebrospinal fluid (CSF) based registration.
  - The initial ROIs are refined via dilation and local optimal search.
- ***Classifier Training/Testing***
  - Positive samples are generated using patches centered at lesion voxels from the whole image.
  - The ROI-specific negative samples are generated using patches centered at healthy voxels in the ROI.
  - Two-layer stacked Autoencoders are used to train and test voxels in each dilated and refined ROI.

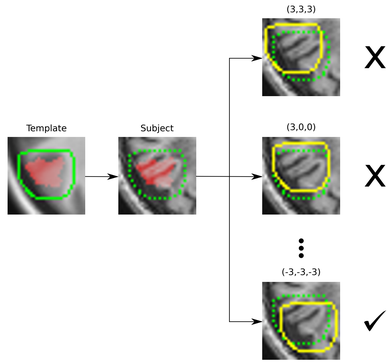
Cerebrospinal Fluid (CSF) based registration



Goal:
After excluding the potential lesions, CSF based registration can help ease the effects of lesion induced healthy tissue deformation (e.g., ventricle dilation).

The transformation matrix is then applied to the original image for image registration.

ROI refinement through dilation and local optimal search



The ROI refinement is achieve by locating the minimum voxel intensity differences between subject and template in pre-defined neighboring searching grids.

Note:
During *testing*, a majority voting scheme is applied to the voxels in the overlapping region.

Experimental results on in-house dataset

Method	Precision	Recall	Dice
Seghier et al. [5]	0.47±0.17	0.54±0.15	0.50±0.15
Sanjun et al. [7]	0.52±0.16	0.60±0.13	0.55±0.13
Guo et al. [13]	0.71±0.15	0.70±0.13	0.69±0.11
Proposed method	**0.75±0.14**	**0.73±0.13**	**0.74±0.11**

Initial ROI	ROI Refine	Precision	Recall	Dice
×	×	0.70±0.15	0.69±0.13	0.69±0.12
✓	×	0.72±0.15	0.69±0.13	0.70±0.11
×	✓	0.71±0.15	0.71±0.13	0.71±0.11
✓	✓	**0.75±0.14**	**0.73±0.13**	**0.74±0.11**