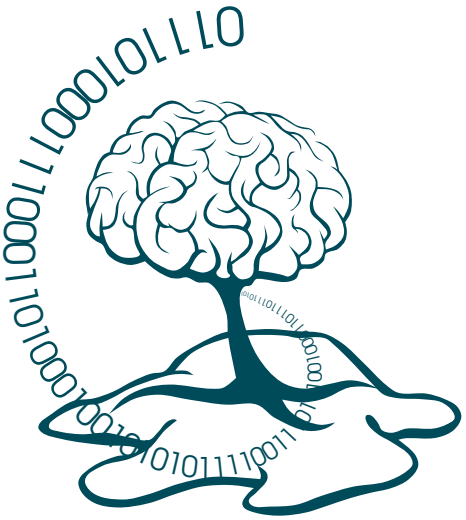

Ischemic Stroke Lesion Segmentation

www.isles-challenge.org

Proceedings

5th October 2015

Munich, Germany

UNIVERSITÄT ZU LÜBECK

Technische Universität München

UNIVERSITÄT BERN

MICCAI'15 MUNICH

Preface

Stroke is the second most frequent cause of death and a major cause of disability in industrial countries. In patients who survive, stroke is generally associated with high socioeconomic costs due to persistent disability. Its most frequent manifestation is the ischemic stroke, whose diagnosis often involves the acquisition of brain magnetic resonance (MR) scans to assess the stroke lesion's presence, location, extent, evolution and other factors. An automated method to locate, segment and quantify the lesion area would support clinicians and researchers alike, rendering their findings more robust and reproducible.

New methods for stroke segmentation are regularly proposed. But, more often than desirable, it is difficult to compare their fitness, as the reported results are obtained on private datasets. Challenges aim to overcome these shortcomings by providing (1) a public dataset that reflects the diversity of the problem and (2) a platform for a fair and direct comparison of methods with suitable evaluation measures. Thus, the scientific progress is promoted.

With ISLES, we provide such a challenge covering ischemic stroke lesion segmentation in multi-spectral MRI data. The task is backed by a well established clinical and research motivation and a large number of already existing methods. Each team may participate in either one or both of two sub-tasks:

SISS Automatic segmentation of ischemic stroke lesion volumes from multi-spectral MRI sequences acquired in the sub-acute stroke development stage.

SPES Automatic segmentation of acute ischemic stroke lesion volumes from multi-spectral MRI sequences for stroke outcome prediction.

The participants downloaded a set of training cases with associated expert segmentations of the stroke lesions to train and evaluate their approach, then submitted a short paper describing their method. After reviewing by the organizers, a total of 17 articles were accepted and compiled into this volume. At the day of the challenge, each teams' results as obtained on an independent test set of cases will be revealed and a ranking of methods established.

For the final ranking and more information, visit WWW.ISLES-CHALLENGE.ORG.

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August 2015

Version: 2015-09-30

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Version: 2015-09-30

Stroke lesion segmentation of 3D brain MRI using multiple random forests and 3D registration

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Abstract. Stroke is a common cause of sudden death and disability worldwide. In clinical practice, brain magnetic resonance (MR) scans are used to assess the stroke lesion presence. In this work, we have built a fully automatic stroke lesion segmentation system using 3D brain magnetic resonance (MR) data. The system contains a 3D registration framework and a 3D multi-random forest model trained from the data provided by the Ischemic Stroke Lesion Segmentation (ISLES) challenge of the 18th International Conference on Medical Image Computing and Computer Assisted Intervention. The preliminary test results show that the presented system is capable to detect stroke lesion from 3D brain MRI data.

1 Introduction

Stroke is a common cause of sudden death and disability worldwide. In clinical practice, brain magnetic resonance (MR) scans are used to assess the stroke lesion presence. A fully automatic random forest based stroke lesion 3D segmentation approach is built. A 3D segmentation framework with backward registration and forward registration is developed for processing the 3D brain data. A machine learning model is trained using the training data provided by the Ischemic Stroke Lesion Segmentation (ISLES) challenge of the 18th International Conference on Medical Image Computing and Computer Assisted Intervention. The preliminary test results show that the presented system is capable to detect stroke lesion from 3D brain MRI data. The outline of this paper is as follows. Section 2 presents the proposed method with the preliminary test results, and section 3 concludes the paper.

2 Method with Preliminary Test Results

A fully automatic machine learning based stroke lesion 3D segmentation approach is built. The data is trained using random forest [2] with the parameters as presented in the Table 1. A large multiple random forest model is developed

to generate potential candidates, and for every five stacks in Z direction, a random forest is trained. In data preparation, the regions of interest (ROI) are extracted to produce training data with two classes using the contour tracing algorithm [1], and 275 image features categorized in 24 types are extracted for training, as illustrated in figure 1.

Obtaining the potential candidates from the machine learning model mentioned above, a 3D registration framework with backward and forward searching is applied to produce optimal 3D predictions, and in the experiments, the 80th stack is selected as the referenced frame for the 3D registration framework. The system flowchart is presented in the figure 2. Figure 3 shows the inputs and system outputs of a 3D brain MRI sample.

Table 1. The parameters used for the multiple random forest model

for each random forest

The maximum depth of the trees	50
The number of trees to be generated	50
The number of features to used	275
The random number seed to be used	1

for the entire 3D segmentation system

The number of stacks to be used to train one random forest	5
The total number of random forests to be built	$N/5$

N: The maximum number of stacks in Z direction.

No.	Features	Attributes	13	Maximum	5
1	Original	1	14	Median	5
2	Hue	1	15	Anisotropic diffusion	10
3	Saturation	1	16	Bilateral	4
4	Brightness	1	17	Lipschitz	5
5	Gaussian blur	5	18	Kuwahara	3
6	Sobel filter	6	19	Gabor	44
7	Hessian	48	20	Derivatives	20
8	Difference of gaussians	10	21	Laplacian	5
9	Membrane projections	6	22	Structure	20
10	Variance	5	23	Entropy	20
11	Mean	5	24	Neighbors	40
12	Minimum	5	Total Feature		275

Fig. 1. Features used for training

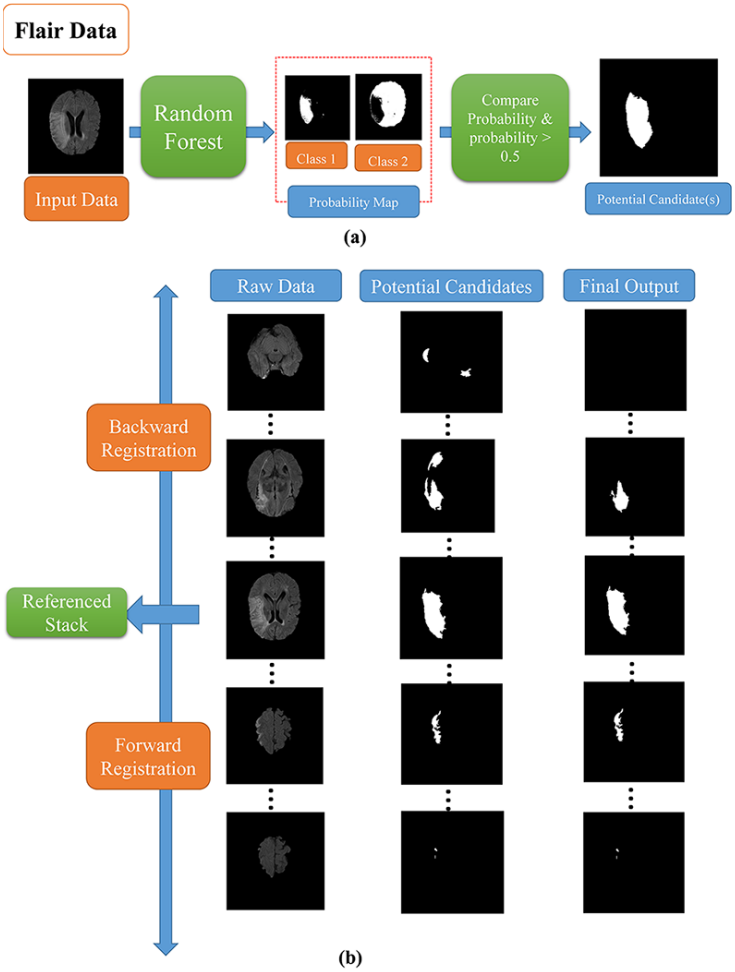

Fig. 2. System flowchart

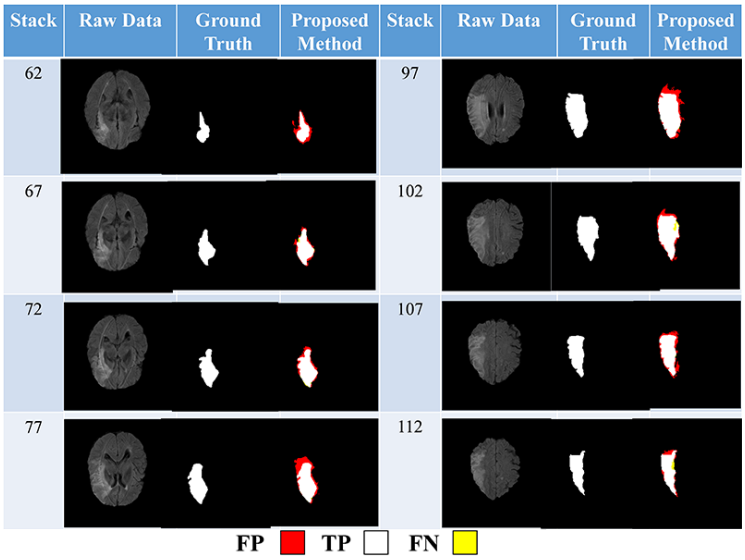

Fig. 3. Inputs and System outputs of a 3D brain MRI sample

3 Conclusion

We have presented a fully automatic stroke lesion segmentation system using 3D brain magnetic resonance (MR) data. The preliminary test results show that the presented system is capable to detect stroke lesion from 3D brain MRI data.

Acknowledgments

Authors would like to thank the Ministry of Science and Technology of Taiwan under Grant No. MOST104-2221-E-011-085 for the financial support.

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