Medical Imaging Analysis :
Lab 3. Image segmentation and evaluation

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VIBOT MSc

Contents

1 Introduction

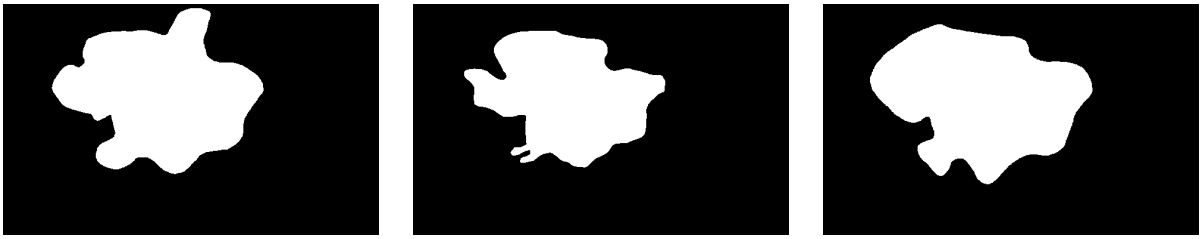
Image segmentation is an important processing step in a Computer Aided Detection / Diagnsosis framework. For instance, it can used to focus further machine learning processing on a specific organ or lesion location. In this lab, we will focus on dermatoscopic images in which the lesion in each image has to be delineated. Thus, this lab will face three typical problems found in segmentation of medical images:

- Ground Truth generation. The problem of multi-expert delineations will be presented and solution to fusion these ground-truth will have to be implemented.
- Segmentation evaluation. Three different methods are proposed to segment the dermatoscopic images. The source code of these segmentation methods and their principles will have to be presented. The results of the segmentation methods will have to be evaluated. Discussions about the metric used have to be given.
- Segmentation Algorithm. Finally, it will be asked to implement your own segmentation algorithm and evaluate the results obtained using the same framework.

2 Ground-truth generation

2.1 Implementation

Several experts proposed a ground-truth segmentation of the original images. These ground-truth images are in the folder `images/gt`. An example is depicted in Fig. 1.
The first task will be to fusion these different opinions to obtain a single ground-truth. You can implement the method of your choice to perform this task. You can also take a look to the following methods to be more inspired: majority voting scheme or STAPLE [1]. Look into the STAPLE folder for an implementation of the STAPLE algorithm in Matlab and ITK.



(a) Expert 1. (b) Expert 2. (c) Expert 3.

Figure 1: Example of ground-truth images from three different experts of a same lesion.

2.2 What to submit

Provide the results and explain the method used to obtain a single ground truth image for each case.
Put the generated ground truth images in the `images/gt/fusion` folder. Keep the original name (eg., "D134_mask.png").

3 Segmentation

3.1 PDF-based segmentation

The code implementing this segmentation method is available in the folder:
`segmentation-algorithms/pdf-based-segmentation`.
Open and execute the `main.m` file, to perform this segmentation.
Check the file `pdfBasedSegmentation.m` in order to understand the principle of this method.

3.2 Level-set segmentation

The code implementing this segmentation method is available in the folder:
`segmentation-algorithms/level-set`.
Open and execute the `main.m` file, to perform this segmentation.
Check the file `levelSetSegmentation.m` in order to understand the principle of this method.

3.3 Fuzzy C-means segmentation

The code implementing this segmentation method is available in the folder:
`segmentation-algorithms/fuzzy c-means`.
Open and execute the `main.m` file, to perform this segmentation.
Check the file `fuzzyCMeansClustering.m` in order to understand the principle of this method.

3.4 What to submit

Provide a brief discussion to explain the principle of each method.

4 Evaluation

4.1 Implementation

The code implementing the different evaluation metrics is presented in the folder: `matlab-evaluation`.

The file to execute is `main.m`. Take a look at the different implemented methods to understand their computation principles.

4.2 What to submit

Report the results obtained. Which method obtains the better results? justify why.

5 Own implementation

As a final step, implement any segmentation method of your choice and evaluate your algorithm using the previous framework implemented (see Sect. 4).

5.1 What to submit

Describe the methodology used and report the results obtained and compare it with the previous results.

References

[1] Simon K. Warfield, Kelly H. Zou, and William M. Wells. Simultaneous truth and performance level estimation (STAPLE): an algorithm for the validation of image segmentation. *IEEE transactions on medical imaging*, 23(7):903–921, July 2004.