Pulmonary Vessel Segmentation Notes

Wei Liu

June 24, 2014

1 Lung Extraction Pipeline

- Threshold the CT image at -2000 to get a *cylinder* mask. The -2000 value may change across patients?

```
fslmaths /scratch/datasets/PE/PE000919.nii.gz -add 2000 -thr 0 -bin
PE919/round_mask.nii.gz
```

- First run GMM with 3 components: lung, tissue, and bones. Initial mean set to -800, 0, 1000, and initial standard deviation of GMM set to 100 for all components. In some cases, we need to run GMM with 2 components.

```
  gmm --input RV01.nii.gz --seg seg.nii.gz --mask round_mask.nii.gz --ncomp 3
  --mean -800 0 100 --sigma 100 100 100 --prop 0.33 0.33 0.33 --maxit 30
```

- Extract the components corresponding to th lung.

```
sitkfuncs.extract_comp('RV01/RV01.nii.gz',
'RV01/gmm_seg.nii.gz', 'RV01/cc.nii.gz')
```

- Use ITK-SNAP to check the label corresponding to the lung. Mostly left and right lung are connected in a single component, so we need only one label. In rare case, they are separated into two components, so we need 2 labels.

- Extract the lung component.

```
 sitkfuncs.extract_lung('RV01/cc.nii.gz', [1],
'RV01/lung.nii.gz', 10)
```

- fill hole in the lung mask with the fillhole filter.

```
fillhole_filter -i lung.nii.gz -o lung.nii.gz
```

2 Vessel Extraction

- Manually define seed regions.
- Estimate the density and get a density map, which will be used as the speed map of fast marching method.

```
est_density -i RV01.nii.gz -e seeds.nii.gz -m lung.nii.gz
-o density.nii.gz
```

  The standard deviation parameter of the density estimation routine controls how much belief the user should give to the seed region. With a small deviation, only the voxels with intensity close to the mean intensity of the seed regions will have larger density value. With a larger standard deviation, the voxel have non-zero density value even its intensity is quite different from the mean intensity. Therefore, the standard deviation parameter can be seen as a regularization. A larger value will make the density map more flat. Vessel and non-vessel voxels density will be similar, and fast marching have more chance to propagate to non-vessel regions.

- Run the fast marching method:

```
fmm_upwind -p density.nii.gz -e seeds.nii.gz -m lung.nii.gz -t 500
-o fmm_out.nii.gz
```

- Inverse the value of the *time of visit* map to get a heat map, where larger values represent vessels.

```
inverse_distmap -i fmm_out.nii.gz -m lung.nii.gz
-o vessel.nii.gz -x 500
```