A machine learning based automatic lung lobe segmentation in Fast Helical Free Breathing CT Scans

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Background

- Lung lobe segmentation is currently done in a semi-automatic manner.
- Semi-automatic lung lobe segmentation is infeasible for processes that require segmentation of multiple CT scans.

Objectives

- To automatically segment the lung lobes in Fast Helical Free Breathing CT (FHFBCT) scans.
- Develop a machine learning based framework for automated segmentation of lung lobes from FHFBCT scans.

Methods

- A set of 10 patient datasets (25 3D FHFBCT scans each) were employed for this study.
- 150 FHFBCT scans were employed for training.
- Lobes were first automatically segmented using Hessian matrix and fissure identification based algorithms.
- Motion blurring errors manually corrected using the Pulmonary Toolkit interface.
- Final segmentations used for adversarial neural network training.
- Generator network segmentation tested using remaining 100 FHFBCT scans.
- Segmentations evaluated using image normalized cross correlation (NCC) metric.

Techniques

- *Neural Network:* the neural network consists of generator and discriminator deep neural networks.
- *Generator Network:* the generator network generated the lung lobe segmentations.
- *Discriminator Network:* the discriminator ensured lobe segmentation accuracy.

Results

(a) Original CT slice. (b) Ground truth segmentation. (c) DNN-generated segmentation.

Figure 1: Example slice of results for upper right lobe segmentation

(a) Original CT slice. (b) Ground truth segmentation. (c) DNN-generated segmentation.

Figure 2: Example slice of results for upper left lobe segmentation

(a) Original CT slice. (b) Ground truth segmentation. (c) DNN-generated segmentation.

Figure 3: Example slice of results for lower left lobe segmentation

- Figure 1 shows an example of the image slice, ground truth segmentation generated by the Hessian matrix and fissure identification-based algorithms, and the DNN-generated segmentation for the upper right lobe. Figure 2 and 3 show the same for upper and lower left lobe, respectively.
- NCC values for lung datasets was consistently >0.9, improving upon <0.7 from the conventional automated segmentation.

Conclusions

- The figures shown offer an example of the general feasibility of a machine-learning generated lobe segmentation.
- An automated machine learning network was successfully used to segment lung lobes from FHFBCT scans in near real-time.
- This provides a tool for automating a key component of pulmonary research and technique development for applications using FHFBCT.

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