

Generating forward models from CT images for ventilation monitoring in ARDS patients

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Abstract: A tool was designed to automatically segment and manually correct boundaries of CT images from ARDS patients to generate custom forward models. These models were used to reconstruct EIT images and estimate global inhomogeneity index of the lungs.

1 Introduction

Acute respiratory distress syndrome (ARDS) is a form of respiratory failure caused by widespread swelling and accompanied by an accumulation of fluid in the lungs. We present a method to use diagnostic CT images to improve EIT model accuracy. ARDS patients may have occlusions from fluid and collapse making it challenging to identify the lung regions correctly. We created a tool to segment and correct the boundaries of the lungs in ARDS patients and compared the resulting model against a generic model using the Global Inhomogeneity (GI) index [1].

2 Methods & Results

Data from 4 ARDS patients with CT and EIT were used to develop a segmentation and correction tool to identify the lungs and boundary of the body. Segmentation was done using the 4th intercostal space, with 10 adjacent CT slices to form an enclosed chest cavity. The lungs and exterior boundary were identified by increasing the contrast and identifying an appropriate threshold. Each segmentation was downsampled to 20 points that could be edited by the user in Matlab. The mesh was generated using `ng_mk_extruded_model` [2] in EIDORS 3.10 [3]. Images were reconstructed using GREIT [4]. The GI index was calculated using the method presented by Zhao et al. [1] using the lung regions from the forward model. A ven-

tilated lung estimate was made using the segmentation as

$$\frac{A_{\text{ventilated lung}}}{A_{\text{total lung}}}$$

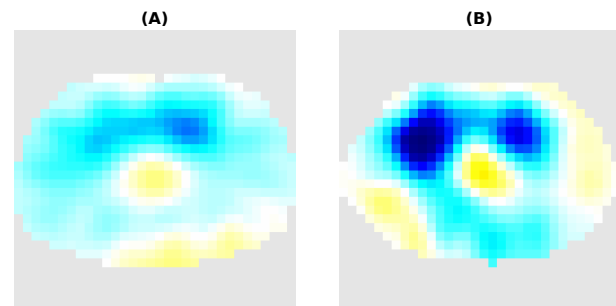


Figure 1: Single breath using: A) generic model B) custom model

Results in fig. 1 show a reconstructed image with more separable lungs in the enhanced model, and a mean GI index for each breath in the 1 minute recording that follows trend of the ventilated lung percentage in table 1.

Table 1: Ventilated lung estimate vs. GI index scores.

Subject	Ventilated lung (%)	GI (basic model)	GI (custom model)
1	99.9	0.353±0.004	0.690±0.005
2	85.5	0.640±0.022	0.771±0.020
3	79.6	0.695±0.007	0.857±0.009
4	27.0	0.614±0.011	1.81±0.053

References

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- [3] A Adler *Conf 19th EIT*, p.63, London, UK, Jun 2009
- [4] A Adler et al. *Physiol Meas*,30:S35-S55, 2009

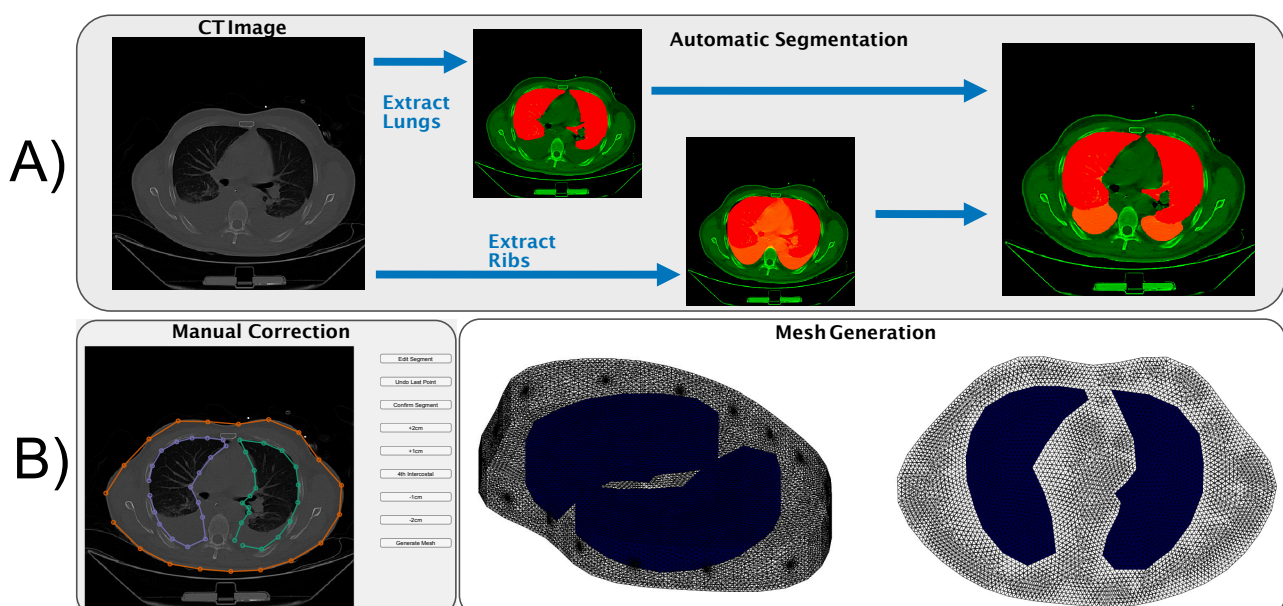


Figure 2: An overview of the segmentation and editing process showing: A) A sample raw CT which was thresholded, scaled and adjusted over several adjacent slices to identify the lung regions and an enclosed rib area, and the resulting lung estimate; and B) A screen capture of the manual mesh correction process and 2 views of the generated mesh.