Algorithm for the modelling of the lung/bronchial tree coupling customised

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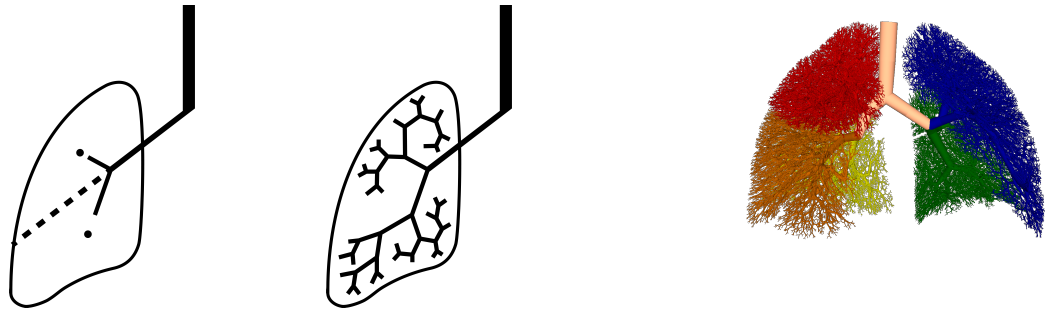
An accurate description of the morphometry of the lung and airways is essential to enable numerical simulations, related to the respiratory system, that are in line with the morphometric observations. The structure of the lung is governed both by its respiratory functions and by the inherent hierarchy of the bronchial tree, making it the complex organ that it is. The airways, defined by an asymmetric dichotomous tree, allow the transport of air to the blood exchange zones and thus the supply of oxygen.

In this paper, we present a scalable algorithm for generating individual-specific 3D models of the bronchial tree, based on morphological structures of the lung lobes and the first three generations of airways. These structures are the result of further work to extract them from a person's CT-Scan, using a Deep Learning method of multi-class segmentation.

The algorithm we present is based on mesh preprocessing, calculating the centre of the largest ball inscribed in a volume by an octree method, and applying physiological constraints.The statistical study of our model, correlated with the different morphometric data, allows us to validate the accuracy and fidelity aspects. The result is a 3D mesh of the lung surface and the bronchial tree that is suitable for numerical simulations.



(a) (b) (c)

Figure 1: Bronchial tree generation in 2D, with our model. (a) Subdivision of the closed area mesh with the cutting plane, calculation of the barycentre and centroid and generation of daughter branches. (b) Repetition of the steps, (c) 3D mesh of the bronchial tree.

Joint work with: André Galligo, Angelos Mantzaflaris, Benjamin Mauroy, Bernard Mourrain.

References

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