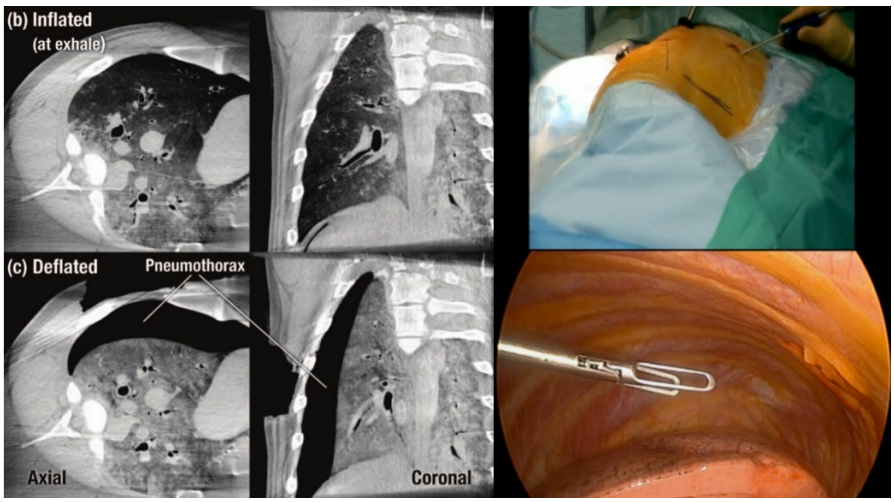
Medical images and biomechanical modeling for guided video assisted thoracic surgery

Recent studies established the interest of screening programs and low-dose CT to detect early stage of lung cancer. Therefore, diagnosis of nodules with unknown histology is increasing dramatically. Lung biopsies performed through video assisted thoracic surgery (VATS) usually provide sufficient material for histological diagnosis. This gesture is initially planned on preoperative CT (identification and localization of nodules) and can be guided on intraoperative Cone Beam Computed Tomography (CBCT).

One of the main problem of VATS is that this technique induces the creation of a pneumothorax at the beginning of the surgery, and consequently a collapse of the lung. The consequence is that the morphology and the density of the lung are changed, modifying so the characteristics of the CBCT images relatively to the preoperative CT one. Thus, it can be difficult or impossible to locate the nodules on the intraoperative CBCT images.

The main goal of the thesis is therefore to develop a guidance system which would integrate in real time the changes induced in the CBCT images and so allow to locate the nodules after the lung collapse. One of the key idea of this thesis is to integrate the morphological changes induced by the pneumothorax in the guidance system.

The general idea of our approach is to integrate and combine a biomechanical lung model into the image processing framework. This model will be defined from the preoperative CT information and then updated during the procedure from the CBCT information. The role of this model will be twofold, on one hand, it will predict the lung density changes in order to improve the nodules detection on the CBCT images and on the other hand, it will be a good indicator of the lung morphology evolution during the therapy in order to improve the guidance.



Lung collapse [Uneri 2013] *Video assisted thoracic surgery [Rouzé 2014]*

Methodological key words :
Image processing (segmentation, enhancement) ; biomechanical model (FEM) ; 3D registration ; fusion and information visualization ; augmented reality.

Thesis context :
This thesis which is supported by the Laboratory of Excellence CAMI is a collaboration between the LTSI (image processing applied to surgical assistance.), University of Rennes 1 and the GMCAO team of TIMC-IMAG (computer assisted medical-surgical procedures), University of Grenoble-Alpes. The PhD candidate will be therefore located at both sites, Rennes and Grenoble (e.g., thesis start and end in Rennes and thesis middle in Grenoble).
This thesis will be in parallel to the PhD Thesis of a MD performing his internship in Thoracic Surgery.

Requirements for the candidate :
- Master or Engineers degree
- Image processing or biomedical engineering specialty
- Knowledge in image processing and registration
- An experience in computer science or programming (C++, itk, vtk ,...) is welcome.
- An experience in FEM modeling and simulation is welcome

Thesis start: September 2016.

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