Continous Media Mechanics simulation of Lung Motion.

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The purpose of this investigation is to simulate and predict the behavior of lungs during cancer treatment with high energy ions. In particular, the simulation allows to estimate tumour positions and lung density distribution, which are important for ion range calculations and dosimetry. Our team gathers the LIRIS laboratory and the ETOILE project, in collaboration with the cancer treatment centre Léon Bérard (CLB) and the respiratory physiology laboratory of the Louis Pradel hospital, all in Lyon, France.

An experimental protocol has been defined by oncologists to provide us with thoracic CT scans in blocked positions taken on the same patient at different periods of the respiratory cycle. The insufflated air volume is quantified with the ABC (Active Breath Coordinator) [3]. An other experimental protocol provides us with physiological parameters, such as compliance [2], which determines the lung elasticity.

In continuous media mechanics method, equations based on physical laws are solved using a numerical method: the finite element technique. In our study various hypotheses are taken into account. In order to model the behaviour in a global way, the lung is assumed to be homogeneous, isotropic and large deformations are possible. The lung geometry is modelled with a first CT scan mesh illustrating the initial state. The lung boundary motion is modelled with the next CT scan mesh representing a subsequent state. An uniform normal negative pressure is applied to simulate the pleural elastic recoil pressure. Adding contact condition constraints to that boundary motion allows us either to block the displacement or to simulate the slip skins.

All the vertex displacements have been computed with an open freeware [1]. A sphere, indicated by a medical doctor, shows a specific area to follow. Finally, it is a first step to check if this numerical method provides plausible results.

A new way in 3D dynamic personalized modelling to track tumour motion has been presented. This study is complementary with a more intuitive method also developed at LIRIS using a mass spring system. The limit of our work is related to anisotropy and heterogeneity and it has to be extended to the lung environment. We also want to study the influence of the organ motion on dosimetry.

1 Aknowledgements

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Références

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