

## Approach to Simulate Tumour Displacements in Lungs with Mass Spring System.

Vincent Baudet, Fabrice Jaillet, Behzad Shariat, Pierre-Frédéric Villard,  
Michaël Beuve, Jean-Yves Bayle, Thierry Quesnel

► **To cite this version:**

Vincent Baudet, Fabrice Jaillet, Behzad Shariat, Pierre-Frédéric Villard, Michaël Beuve, et al.. Approach to Simulate Tumour Displacements in Lungs with Mass Spring System.. 9th workshop on Heavy Charged Particles in Biology and Medicine, 2003, Lyon, France. hal-00849209

**HAL Id: hal-00849209**

**<https://hal.inria.fr/hal-00849209>**

Submitted on 30 Jul 2013

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Approach to simulate tumour displacements in lungs with mass spring system.

Vincent Baudet, Fabrice Jaillet, Behzad Shariat, Pierre Frédéric Villard, Michael Beuve,  
Jean Yves Bayle, Thierry Quesnel,  
Chantal Ginestet, Vlad Boldea, David Sarrut, Sebastien Clippe, Christian Carrie  
[vbaudet,fjaillet,bshariat]@liris.univ-lyon1.fr

## 1 Abstract

Our team gathers medical, physical and computer science researchers to develop a personalised simulation of lungs in order to predict tumour displacements and deformations during cancer treatment with ionising.

In this context, a mass spring system model, which is monitored by breathed volume is presented.

The shape of the simulated lungs is based on segmented computer tomography (CT) scans performed while the patient's respiration is blocked by an active breath control (ABC) system [2]. After data acquisition and segmentation, the volume is meshed with tetrahedrons. The elasticity is obtained from a global measurement of the lung resistivity to volume expansion, the compliance [1]. A realistic behaviour should be expected adding constraints defined by *a priori knowledges* on the lung environment.

The simulation consists in applying forces due to the organ activity or interaction with its environment and then to solve the dynamic equations on each node of the mesh. The forces can be calculated from the compliance and the volume variation of the organ. As a control parameter, the volume variation monitor the model. In parallel, studies are proceeded by medicines to prove that volume is a parameter for geometry reproductibility.

Our results show a meshed lung inflated and deflated according to a sinusoidal breathed volume. The lung volume well follows the imposed volume variation. The displacements from the rest position, for each node of the mesh are obtained. As no environmental constraints were applied, this displacements do not have any meaning. However, this illustrates how one can estimate every displacement in the lung and in tumours in the future.

A medical protocol is already defined to provide us with data of three different volumes of the lungs in order to verify our model. In parallel, to verify accuracy, a complementary model based on continuous mechanics is developed. The future work will be to incorporate environmental structures, heterogeneity and anisotropy and to compare our results with data obtained from our partners.

## 2 Acknowledgement

We like to thank La Ligue Contre Le Cancer and ETOILE project for their financial support.

## References

- [1] Marylin L. Moy and Stephen H. Loring. Compliance. *Seminar in respiratory and critical care medecine*, 19(4):349–359, 1998.
- [2] J. W. Wong and al. The use of active breathing control (abc) to reduce margin for breathing motion. *Int. J. Radiation Oncology Biol. Phys.*, 44(4):911–919, 1999.