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LUNG DEFORMATION SIMULATION BASED ON MEDICAL IMAGES AND MOTION MODELS OF DIAPHRAGM AND RIBS USING THE MPS METHOD

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In radiation therapy for lung cancers, lung motion due to breathing is required to consider for reducing the radiation dose to the normal tissue. The lungs can be treated as a soft elastic material which is surrounded by a diaphragm and ribs. The diaphragm and ribs are actively moved for breathing. The lungs are passively deformed by the motion of the boundaries. The MPS (Moving Particle Simulation) method[1] is applied to this problem.

The shapes of lungs, a diaphragm and ribs are constructed from patient's medical images. Particles are generated in these regions. Particle generation is robust for the medical images involving noises. The lungs are moved by the forced motion of boundaries. The physical properties of the lungs are assumed to be uniform. Medical images of the breathing phases are made from the simulation results.

The lung boundaries are moved by a diaphragm and ribs. The motion models are developed for them. The shape of the diaphragm is basically obtained from patient's images, but the whole diaphragm is not usually provided in the images. The regions out of the images are generated using the anatomical model. The diaphragm consists of muscles and tendons. Contraction force is assumed between the muscle particles corresponding to the breathing curve.

The shapes of ribs are obtained from patient's images. The rotation axes of the ribs are identified on the spine. Each rib is rotated around the identified axis corresponding to the breathing curve.

The calculation results are compared with the measured images as validation. Good agreement is obtained at most positions in the lungs. We need to improve the assumptions to enhance the simulation accuracy.

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