Palestra

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Patient specific computational models of cardiac electro-mechanics

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Resumo

Several challenges arise in taking computer simulations of cardiac electro-mechanical interactions from the research lab into the clinic. Obvious difficulties include fitting geometries and model parameters to the individual patients, model validation and verification, and the time restrictions imposed by clinical use. Several studies may be found in the literature. Most studies focus on image-based geometry reconstruction, while some present case studies and prototypes of a complete modeling pipeline.

In this presentation we report on a number of early results related to constructing patient-specific models ofstrongly coupled cardiac electro-mechanics. The models are based on echocardiographic (echo) images and patientdata from Oslo University Hospital, for patients diagnosed with heart failure and/or increased risk of suddencardiac death. Established mathematical models are used for cardiac electrophysiology and mechanics; thebidomain model coupled to the equilibrium equation of non-linear hyperelasticity. The coupling is based on anactive stress formulation, and on systems of ordinary differential equations that describe cell electrophysiology,calcium dynamics and contraction.

Tagged magnetic resonance (MR) images with tagging are considered the gold standard for reconstructing cardiac geometries and fitting material parameters. Echo images, while clearly advantageous in terms of cost and acquisition time, generally offer less accuracy and detail than cardiac magnetic resonance images. This gives rise to additional challenges in reconstructing ventricular geometries, in particular for the right ventricle, which is poorly represented in echo. From a single image dataset we build finite element models based on linear tetrahedra and triquadratic hexahedra, and compare results in terms of accuracy and efficiency.

Informações

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