27th IFIP TC7 Conference 2015 on System Modelling and Optimization

Optimal control and Hamilton-Jacobi-Bellman equations: Numerical methods and Applications

Primal-dual active set strategy for large scale optimization of cardiac defibrillation

Nagaiah Chamakuri

Johannes Kepler University, Linz, Austria

nagaiah.chamakuri@ricam.oeaw.ac.at

Abstract: In tis talk we present a feasible study of optimal control techniques for cardiac defibrillation on the basis of the bidomain equations posed on a rabbit ventricle geometry. The bidomain model consist of a system of elliptic partial differential equations coupled with a non-linear parabolic equation of reaction-diffusion type, where the reaction term, modeling ionic transport is described by a set of ordinary differential equations. An extra elliptic equation for the solution of an extracellular potential needs to be solved on the torso domain. The optimal control approach is based on minimizing a properly chosen cost functional depending on the extracellular current as input at the boundary of torso domain, which must be determined in such a way that wavefronts of transmembrane voltage in cardiac tissue are smoothed in an optimal manner. In parallel computations, the domain decomposition of such realistic geometry consists of heart surrounded by torso is not a trivial task. In this talk, I will present domain decomposition techniques and their efficient implementation of such PDE constrained optimization of bidomain model. A primal-dual active set strategy is employed for treating inequality control constraints. A parallel finite element based algorithm is devised to solve an optimal control problem on such complex geometries and its efficiency is demonstrated not only for the direct problem but also for the optimal control problem.
This is a joint work with Prof. Karl Kunisch, University of Graz, Austria.