IDENTIFICATION OF AN ELECTROPHYSIOLOGICAL MODEL FROM COMBINED ECG AND MRI

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Abstract. In the recent years, data assimilation techniques have been proposed to estimate the state and the parameters of patient-specific mechanical models of the myocardium. In the present work, we consider a coupled electromechanical model in order to take advantage of different sources of clinical exams (typically MRI and ECG). The mathematical structure of the electrocardiology equations (nonlinear reaction-diffusion problems) makes it difficult to extend the techniques used in mechanics, namely a Luenberger filter for the state and a Reduced Order Unscented Kalman filters (RO-UKF) for the parame- ters only. To address this challenging task, we propose to project the electrical state on a basis obtained by Proper Orthogonal Decomposition (POD) and to only filter the first components with the RO-UKF algorithm. This is the first contribution of this work. The second contribution is to address the state-parameter estimation on a coupled system including the mechanics of the myocardium, the bidomain equations for the heart electrophysiology and an ECG simulator. Of particular interest is the information on electrophysiology provided by mechanical observations, that would not have been detectable by the ECG only. We show in particular that for some electrical parameters the mechanical response is longer in time than the electrical response observed on the ECG. The proposed approach paves the way for the personalization of a complete electromechanical heart model.

Keywords: Electro-mechanics, electrocardiogram, MRI, Unscented Kalman Filter, Reduced filtering, POD

Mathematics Subject Classifications (2000): 35R30, 45Q05, 65C20, 65M32, 92C10.

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