Parameters Estimation and Optimal Control of the Ding et al. Model to Optimize the Muscular Response To Electrical Stimulations

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Abstract: In biomechanics, recent mathematical models [1] allow to predict and to optimize the muscular force response to functional electrical stimulations . In this talk we consider a model validated experimentally called the Ding et al. model which takes into account the muscular fatigue. The control parameters are the time of applications and the amplitudes of the electrical pulses. The cost objective is to track a reference force while minimizing the fatigue. Completing earliest results [2] we discuss the problem of estimating the parameters. We describe two methods to compute optimized train pulses. The first one is a Model Predictive Control Methods and the second one uses an approximation of the force response [3]. We present numerical stimulations aiming to validated both methods in connection with fast real time computations related to an ongoing industrial project aiming to design a smart electrostimulator.

References:

[1] E. Wilson. Force response of locust skeletal muscle. *Southampton University, Ph.D. thesis*, 2011.

[2] T. Bakir, B. Bonnard, L. Bourdin, J. Rouot Pontryagin-type conditions for optimal muscular force response to functional electrical stimulations. *J. Optim. Theory Appl.*, 184:581–602, 2020.

[3] T. Bakir, B. Bonnard, S. Gayrard, J. Rouot Finite Dimensional Approximation to Muscular Response in Force-Fatigue Dynamics using Functional Electrical Stimulation. Under revision *Automatica*.