University of South Florida

Joint Differential Equations and Mechanical Engineering Seminar

January 30, 2015, 1PM, NES 108

Speaker: Michael Malisoff, Louisiana State University

Title: Tracking Control for Neuromuscular Electrical Stimulation

Abstract: We present a new tracking controller for neuromuscular electrical stimulation, which is an emerging technology that can artificially stimulate skeletal muscles to help restore functionality to human limbs. We use a musculoskeletal model for a human using a leg extension machine. The novelty of our work is that we prove that the tracking error globally asymptotically and locally exponentially converges to zero for any positive input delay and for a general class of possible reference trajectories that must be tracked, coupled with our ability to satisfy a state constraint. The state constraint is that for a seated subject, the human knee cannot be bent more than plus or minus 90 degrees from the straight down position. Also, our controller only requires sampled measurements of the states instead of continuous measurements and allows perturbed sampling schedules, which can be important for practical applications where continuous measurement of the states is not possible. Our work is based on a new method for constructing predictor maps for a large class of nonlinear time-varying systems, which is of independent interest. Prediction is a key method for delay compensation that uses dynamic control to compensate for arbitrarily long input delays.

Speaker's Biography: Michael Malisoff received his PhD in 2000 from the Department of Mathematics at Rutgers University in New Brunswick, NJ. In 2001, he joined the faculty of the Department of Mathematics at Louisiana State University in Baton Rouge (LSU), where he is now the Roy Paul Daniels Professor #3 in the LSU College of Science. His main research has been on controller design and analysis for nonlinear control systems with time delays and uncertainty and their applications in engineering. One of his projects is joint with the Georgia Tech Savannah Robotics team, and helped develop marine robotic methods to help understand the environmental impacts of oil spills. His more than 100 publications include a Springer monograph on constructive Lyapunov methods. His awards include the First Place Student Best Paper Award at the 1999 IEEE Conference on Decision and Control, two three-year National Science Foundation Mathematical Sciences Priority Area grants, and 9 Best Presentation awards in American Control Conference sessions. He is an associate editor *for IEEE Transactions on Automatic Control* and for *SIAM Journal on Control and Optimization*.