McCormick

Northwestern Engineering

Electrical Engineering and Computer Science

EECS Seminar:

Prof. Michael Malisoff

Professor, Dept of Mathematics, Louisiana State University

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.

Bio: **Prof. Michael Malisoff** *is the Roy Paul Daniels Professor #3 in the LSU College of Science. He earned his PhD in Mathematics in 2000 from Rutgers University in New Brunswick, NJ. His research is on systems and control, with an emphasis on engineering applications. He has studied control problems for active magnetic bearings, bioreactors, DC motors, human heart rates, marine robots, microelectromechanical relays, neuromuscular electrical stimulation, and unmanned air vehicles. He received the First Place Student Best Paper Award at the 1999 IEEE Conference on Decision and Control, two 3-year NSF 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.*

Date: Friday, October 2, 2015 at 2:00pm

Location: Tech Room L440

Seminar Host: Prof. Randy Freeman

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