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GATOR Engineering®

Fall 2016 Seminar Series

Department of

Mechanical & Aerospace Engineering

Dr. Michael Malisoff

Roy Paul Daniels Professorship

Department of Mathematics

College of Science, Louisiana State University

Presentation 1
Thursday November 17, 2016
10:30 - 11:30AM, 334 MAE-B

Adaptive Planar Curve Tracking Control with Unknown Curvature

The adaptive tracking and parameter identification problem entails designing (a) a tracking controller that ensures that all solutions of a given control system track a desired reference trajectory and (b) a dynamic extension called an update law whose state asymptotically converges to the unknown parameter vector in the original given control system. This talk will explain the speaker's solutions to adaptive tracking and parameter identification problems in 2D curve tracking, where the unknown parameters are the control gains and the curvature. The convergence proofs are based on new constructions of barrier Lyapunov functions. The work is motivated by the speaker's recent study of residual pollution from the Deepwater Horizon oil spill disaster, which used commercial and student-built marine robots to generate crude oil concentration maps in a lagoon at Grand Isle, Louisiana.

Seminar Presentation
Thursday November 17, 2016
4:00-5:00PM, 303 MAE-A

Constructions of Strict Lyapunov Functions: Stability, Robustness, Delays, and State Constraints

This is one of a series of talks by the speaker on constructions of strict Lyapunov functions and related applications. This seminar will provide all of the needed background and definitions to be understandable to graduate students and others who are familiar with the basic ideas of control systems. The construction of strict Lyapunov functions is important for proving stability and robustness properties for nonlinear control systems. The Matrosov approach involves combining known nonstrict Lyapunov functions for nonlinear systems with one or more so-called auxiliary functions, to build strict Lyapunov functions. This seminar will present a method for building the required auxiliary functions, based on iterated Lie derivatives, and will include an application to a Lotka-Volterra dynamics. Two more talks in the series will take place on Friday November 18th in 334 MAE-B from 10:30-11:30AM and from 3:00-4:00PM.

Refreshments served in 303 MAE-A beginning at 3:50 pm

Presentation 2
Friday November 18, 2016
10:30-11:30AM, 334 MAE-B

Lyapunov-Krasovskii Functionals

Starting from a strict Lyapunov function for a controlled system without input delays, it is often possible to add integral terms to obtain a Lyapunov-Krasovskii functional for the corresponding input delayed system, and to find a range of admissible values for the delays that ensure robust asymptotic stability properties under control or model uncertainties. This contrasts with prediction or reduction methods that take the delay value into account in the control design. Although prediction and reduction often compensate for arbitrarily long delays, a potential advantage of the Lyapunov-Krasovskii approach is that it allows us to use simpler controllers that were originally designed for systems without delays. This lecture will discuss the Lyapunov-Krasovskii approach, including illustrations involving a key curve tracking dynamics that arises in marine robotics.

Presentation 3
Friday November 18, 2016
3:00-4:00PM, 334 MAE-B

Robust Forward Invariance

Many applications such as collision avoidance problems require that tracking objectives be met, while also keeping the state in certain safe regions of the state space. Robust forward invariance can be used with Lyapunov-Krasovskii functionals to provide predictable tolerance and safety bounds that ensure that systems respect state constraints. It is a novel variant of the strong invariance property for differential inclusions, with the additional useful feature that it provides maximum allowable perturbation sets that the system can tolerate without violating the required tolerance and safety bounds. This lecture will discuss applications of robust forward invariance to human-pointer interactions under pointer acceleration, and to 3D curve tracking under delays and state constraints where an adaptive controller is used to identify unknown control gains.

Biography

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. 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 has served as Associate Editor for IEEE Transactions on Automatic Control and for SIAM Journal on Control and Optimization.