SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS

Final Program

SIAM Conference on Control in the 90's: Achievements, Opportunities, and Challenges

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Sponsored by the SIAM Activity Group on Control and Systems Theory

CONFERENCE THEMES

- Linear Systems
- Discrete Event Dynamical Systems
- Nonlinear Systems
- Stochastic Systems
- Identification and Control of Fluids
- Adaptive Control
- Computation and Control
- Optimal Control
- Estimation
- Identification
- Robust Control
- Control of Queues and Networks
- Distributed Parameter Systems
- Decentralized Control
- Robotics
- H-Infinity Control

#40/11:20 AM

How Difficult Constrained Control Problems Are?

We consider a linear–quadratic optimal control problem (P) with a constrained control set. We show the existence of an unconstrained linear–quadratic optimal control problem such that minimizers of (P) can be recovered from minimizers of the unconstrained problem. However the construction of the unconstrained problem is equivalent to the construction of a functional separating two convex sets in a Hilbert space. The latter may or may not be an easy problem. We show the existence of a countable family (P_N) of unconstrained linear–quadratic problems whose minimizers approximate (in an appropriate norm) minimizers of the original constrained problem (P).

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#145/11:40 AM

The Hyperplane Method for Reachable State Estimation

Reachable state sets for controlled, dynamic systems provide useful descriptions of system capability and performance. The Hyperplane Method presented for linear, time-invariant systems with bounded inputs generates inner and outer approximations to the reachable set, characterized by bounding hyperplanes in the state space. Analytical error bound results are derived and guarantee a user-prescribed degree of accuracy for the approximations. The Hyperplane Method can be employed iteratively to determine input bounds that guarantee satisfaction of (given) system performance, state, and operating constraints. An example illustrates the approach. Applications for control system design and fault tolerance studies are also discussed.

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CONTRIBUTED PRESENTATIONS 22

Room: Telegraph A

ROBOTICS

Tzyh-Jong Tarn

#2/10:00 AM

Optimal Control of Robotic Manipulators with Obstacles Avoidance

In this paper, optimal motion and trajectory planning with obstacles avoidance schemes for robotic manipulators are solved by a method of Sequential Gradient-Restoration Algorithm. Numerical examples of a two degree-of-freedom robotic manipulator are demonstrated to show the optimal trajectory avoids the obstacle. The obstacle is put on the midway, or even further inward, of the previous no-obstacle optimal trajectory on purpose. The minimum-time motion successfully avoids the obstacle. The minimum-time is longer for the obstacle avoidance cases than the one without obstacle. For the minimum-time purpose, the trajectory tangentially grazes by the obstacle. The obstacles avoidance schemes can deal with multiple obstacles in any ellipsoid forms by using artificial potential fields as penalty functions via distance functions. The algorithm is very efficient to solve optimal control problems for robotics with obstacles avoidance and can be applied to any degree of freedom robots with any performance indexes as well and mobile robots, too. Since this algorithm generates true minimum solution based on Pontryagin principle, rather than an approximation to it, the results provide an ideal benchmark against which the merit of any other algorithms can be measured.

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#163/10:20 AM

Is it time to re–think robot control?

Present-day industrial robots generally perform deterministic tasks within well-defined workstations. These robots employ point-to-point positioning control strategies and operate with minimal sensory feedback. Monitoring procedures are typically confined to sequence verification such as task initiation/completion, presence/absence of parts, hazard detection and safety violation. System performance is affected by gravity, load changes, and speed of execution, and varies in the workspace. This conventional approach capitalizes on the robot's ability to learn repetitive tasks and execute them over a long period of time. We believe that the integration of the mechanical and controller designs is going to be the fundamental characteristic of the next generation of industrial robots. This integration will necessitate the use of intelligent control to execute complex robotic tasks. Intelligent control will reduce the uncertainty in the controller by coupling system theoretic approaches with learning methodologies.

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