Feedforward Control for Precision Tracking and Cohesive Decentralized Networks

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Goal: The addition of feedforward tends to improve any feedback control provided the model uncertainty is small. Therefore, inversion-based feedforward is used to improve precision in applications such as soft robotics (with flexible structures for torque sensing), atomic force microscopes, and vertical take-off and landing aircraft. The goal of this short course is to provide advanced control theory concepts in precision control to graduate students who are interested in doing research in this area. In particular, the course emphasizes the design of control inputs, which can be used as a feedforward input, to achieve precision output tracking control. Challenges in this design such as the inversion of non-minimum phase systems, the handling of plant uncertainty, as well as online implementation issues will be reviewed. Finally, feedforward-feedback based techniques are used to develop a delayed self-reinforcement (DSR) approach for cohesive decentralized networks, with applications in multi-agent control systems. Additionally, the course will emphasize MATLAB-based simulation of applications.

Prerequisites: Linear Systems or Control theory
Must know how to use MATLAB for Modeling and Simulation

	Lecture	**MATLAB Classwork**
Lecture 1	1) Introduction to Inversion-based Feedforward 2) Integration with feedback 3) Challenges in inverting nonminimum phase systems	1) Feedforward inversion 2) Integration with feedback 3) Apply to simulation model of flexible structures, e.g., soft robots
Lecture 2	Optimal Inverse Feedforward	Optimal inverse as a prefilter Actuator redundant case
Lecture 3	Iterative Machine Learning using GPR-based model inverse	Convergence rate, uncertainty estimation
Lecture 4	Ideal feedforward +feedback for cohesive decentralized networks using delayed self-reinforcement (DSR)	Comparison of cohesion with and without inverse

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