Learning and Adaptive Control

Dates and Time

16-10-2023
23-10-2023
30-10-2023
06-11-2023
from 10.15-12.30

Course Location

Cursus- en vergadercentrum Domstad, Utrecht

ECTS

3 ECTS if the homework assignments are completed successfully.
1 ECTS for auditing the entire course.

Lecturers

Dr. ir. Wouter B. J. Hakvoort, University of Twente
Dr. Hakan Köroğlu, University of Twente

Objective

This course presents selected material on learning and adaptive control. It is divided into two parts, each of which consists of two lectures. In the first part, the basics of disturbance observers, iterative learning control and adaptive feedforward control are discussed. The first lecture will be on disturbance observers and iterative learning control, while the second lecture will focus on adaptive feedforward control and online parameter estimation. In the second part, methods for direct adaptive control of continuous-time systems will be discussed within the framework of model reference control. The third lecture will be on adaptive control with perfect state measurements, while the fourth lecture will focus on adaptive control based on output feedback.

Contents

1. DISTURBANCE OBSERVERS AND ITERATIVE LEARNING CONTROL

- Inversion Based Disturbance Observers
- Extended State Disturbance Observers
- Iterative Learning Control
- Iterative Learning Control for Non-minimum Phase Systems

2. ADAPTIVE FEEDFORWARD CONTROL

- Iterative Learning Control with Basis Functions
- Adaptive Feedforward Control
- Disturbance Feedforward Control
- Online Parameter Estimation (RLS, LMS and Kalman filters)

3. ADAPTIVE STATE FEEDBACK CONTROL

- Model Reference State Feedback for State Tracking

- Adaptive Model Reference State Feedback

- Adaptive Model Reference State Feedback for Output Tracking

4. ADAPTIVE OUTPUT FEEDBACK CONTROL

- Model Reference Output Feedback for Output Tracking

- Adaptive Model Reference Output Feedback: Plants with Relative Degree One

- Adaptive Model Reference Output Feedback: General Plants

Course materials

Lecture slides and recommended reading material will be made available on the DISC course platform.

Prerequisites

A basic graduate course on systems and control (with contents including state-space and transfer function models, controllability/observability, stability analysis in the frequency domain, Lyapunov stability theory) is a prerequisite. A recap/self-study of basic results from calculus and functional analysis will be needed as well. MATLAB/SIMULINK will be used to do the homework assignments.

Homework Assignments

There will be four homework assignments (i.e. one assignment per lecture), which will be distributed via the course platform. Assignments will be graded on a scale from 1 to 10 (with 1 given as the base grade for any submission). The final grade for the course will be an average of the grades for the homework assignments.