Control under Communication Constraints 2019–2020

Assignments

1. Homework assignments will be handed out at the conclusion of each topic.
2. Final exam (Exam 1: 16/07/2020, 2 pm; Exam 2: 11/08/2020, 2 pm).
3. Class presentation of one of the topics listed in class (or a different approved topic).
4. Complementary final work.

Course Outline

1. Background: Control over noisy communication media (CONCOM)
2. Linear control
   a. Linear quadratic regulator (LQR)
   b. Kalman filter
   c. Linear quadratic Gaussian (LQG) control
   d. Control–estimation separation
   e. LQG control with integral control action (reference-signal tracking)
3. Networked control and CONCOM
   a. Control–estimation separation for networked control and CONCOM
   b. Source–channel separation for classical communications
   c. Source–channel separation limitations for CONCOM
4. Control over noiseless (quantized) channels
   a. Control over fixed-rate channels
   b. Control over variable-rate channels
   c. Performance impossibility bounds
   d. Event-triggered control
5. Control over packet-drop channels (intermittent observations)
   a. TCP vs UDP
   b. Infinite rate packets
   c. Finite rate packets
   d. Delayed acknowledgments
6. Anytime reliability
   a. Tree codes
   b. Linear time-invariant tree codes
7. CONCOM
   a. Via source–channel separation
   b. Via joint source–channel techniques
   c. Impossibility bounds via source–channel separation
   d. Refined joint source–channel coding impossibility bounds

8. Control over noisy channels in the presence of channel output feedback
    a. Posterior matching
    b. Sequential Bayesian filtering
9. Distributed setups
    a. Parallel sensors
    b. Control-action knowledge (and lack thereof) at the sensor(s)
    c. Controller with both colocated and non-colocated sensors
    d. Real-time relaying

Bibliography:

1. K. J. Åström. *Introduction to Stochastic Control Theory.* Academic Press, 1970.
2. K. Zhou, J. C. Doyle, and K. Glover. *Robust and Optimal Control*. Prentice Hall, 1996.
3. M. Green and D. J. N. Limebeer. *Linear Robust Control.* Courier Corporation, 2012.
4. S. Yüksel and T. Başar. *Stochastic Networked Control Systems: Stabilization and Optimization under Information Constraints.* Birkhäuser, 2013.
5. A. Gersho and R. M. Gray. *Vector Quantization and Signal Compression*. Kluwer Academic Pub., 1992.
6. N. S. Jayant, P. Noll. *Digital Coding of Waveforms – Principles and Applications to Speech and Video*, Englewood Cliffs, 1984.
7. S. Särkkä. *Bayesian Filtering and Smoothing*. Cambridge University Press; 2013.
8. S. Dharmadkhikari and K. Joag-Dev. *Unimodality, Convexity, and Applications*, Academic Press, Inc., 1988.

Additional papers will be provided throughout the semester.