Final Comments

IEEE ICMA 2006 Tutorial Workshop

Iterative Learning Control
Algebraic Analysis and Optimal Design

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## Further Research on ILC, If Any?

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- Classical Arimoto algorithm
- Owens’ multipass problem
- General (higher-order) problem
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- Most general problem
- Frequency-domain uncertainty
- Least quadratic ILC
- Stochastic ILC (general)
- Interval ILC
- Time-domain $H_\infty$ problem
- Iteration-domain $H_\infty$ ILC
- Iteration-varying uncertainty and control
- Intermittent measurement problem
Further Research on ILC, If Any?

• ILC relatively matured.
• Inherently “robust”, less model-based, tolerant to slight nonlinearities.
• Transient and monotonic issues were not well handled but are now gaining attention.
• Applications to PDE systems not well understood.
• ILC for fractional order dynamic systems (polymer/piezo/silicon gel etc)
• ILC for large-scale uncertain spatial-temporal interconnected systems.
• ILC in network control systems (NCS) setting (telepresence/tele-training)
• Nonlinear updating laws? Why bother? Nonlinear feedback takes care of it.
• Repetitive control obeys the “waterbed effect”. ILC may not, due to the resetting operation, but ILC must obey the waterbed effect in the iteration domain.
Other Ideas

- Intermittent ILC? (intermittent sensing, actuation, learning updating)
- ILC with nonuniform sampling, asynchronous ILC?
- Joint time-frequency domain ILC (techniques: wavelet, TFR, even fractional order Fourier transformation – our IEEE CIRA01 paper “Frequency-domain adaptive learning feedforward control”)
- Cooperative ILC with over-populated (or densely distributed) sensors and actuators, possibly networked, each with dynamic neighbors under uncertain communication topologies.
- Iterative learning consensus building for collective iterative learning control
- Memory and communication are getting cheaper and cheaper: can envision “ubiquitous collaborative iterative learning”.
- ...
- ...
Thank you!

- ILC web: www.csois.usu.edu/ilc
  - Maintained by Prof. YangQuan Chen
  - Links to presentations from 2003 ILC Summer School organized by Prof. Kevin Moore
  - Many other links
- Hyo-Sung Ahn’s 2006 Ph.D. Dissertation:
  - http://www.csois.usu.edu/people/hyosung/phd.pdf (324 pages, 586 references cited.)
- Forthcoming new ILC monograph on robust ILC, Springer 07 (expected)
References by the Presenters

Books and Surveys


Other Workshops


Robust ILC

“Stability analysis of iterative learning control systems with interval uncertainty,” Hyo-Sung Ahn, Kevin L. Moore, and YangQuan Chen, accepted to appear in *Automatica*.


Monotonic and Optimal ILC


Monotonic and Optimal ILC (cont.)


Foundations


New Directions


“Spatial-Based ILC for Motion Control Applications,” Kevin L. Moore, Mohua Ghosh, and YangQuan Chen, submitted to *Mechanica*.


Other


