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Recent Advances in Iterative Learning and Repetitive Control for Industrial Nonlinear Batch Manufacturing Systems

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Abstract

Iterative Learning Control (ILC) and repetitive control (RC) are high-performance tracking control design methods for systems operating repetitively or periodically. They adapt the control effort based on information collected from previous trials, and thus can lead to significantly better performance than conventional control design approaches even without using accurate system model information. This becomes of special importance for the data-driven control of industrial batch manufacturing systems, which usually leads to challenging non-linear problems. This special session aims to bring together results representing the dominant analysis and design paradigms, address new theoretical challenges, and present emerging applications.

Detailed Description of the Topic

Iterative Learning Control (ILC) and repetitive Control (RC) are high-performance tracking control design methods for systems operating in a repetitive or periodic regime. To achieve this, they both adapt the control effort based on information collected from previous trials (periods). Compared to conventional control design approaches, ILC and RC potentially lead to significantly better performance, even under a significant level of uncertainty, e.g. without accurate system model information or the presence of highly noised observations. Originating from robotic research, ILC and RC have attracted intensive research effort and have proven to be extremely successful in achieving attractive system performance in a wide range of application domains, including batch manufacturing processes, additive manufacturing, chemical batch processes, etc.

After several decades, ILC and RC have progressed considerably in both theoretical research and their practical application with a number of new design/analysis methods and emerging applications reported. This special session aims to:

- Bring together results representing the dominant analysis and design paradigms, including frequency-domain design, optimization based approach, internal model design, design for nonlinear systems
- Address new theoretical challenges in ILC and RC, including:
  - model-free robust control of nonlinear batch manufacturing systems and batch performance optimization subject to time-varying process uncertainties,
  - anti-disturbance control and performance optimization for nonlinear batch manufacturing systems,
  - robust control of nonlinear batch manufacturing systems and performance optimization subject to non-identical initial conditions and variable batch periods.
  - other aspects in data-driven and optimization-based approaches, as well as their connection and comparison to alternative learning-based control approaches,
- Present new emerging and non-traditional applications.