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SPATIAL-BASED ADAPTIVE ITERATIVE LEARNING CONTROL OF NONLINEAR ROTARY SYSTEMS WITH SPATIALLY PERIODIC PARAMETRIC VARIATION

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Abstract. *A new spatial-based iterative learning control design for a class of rotary systems with unknown spatially periodic parameters is proposed in this paper. The concept of parametric adjustment in conventional adaptive control is modified and interfaced with spatial-based iterative learning control, i.e., a periodic parametric update law is identified for minimization of the tracking error. Convergence property and stability proof of the overall system are analyzed and discussed. Feasibility and effectiveness of the proposed scheme is justified by an illustrative example with numerical simulation. Compared with existing spatial-based iterative learning designs, the proposed approach applies to a more generic class of nonlinear and high-order systems.*
Keywords: Adaptive control, Iterative learning control, Motion control

1. **Introduction.** Motion systems play important roles in various industry, e.g., packaging, printing, assembly, fabrication, semiconductor, robotics, etc. A conspicuous configuration of motion control systems comprises actuators and sensors to regulate and measure the position and velocity of the load, and a so-called controller to interface measured/command signals from/to the sensors and actuators. Most applications require a motion system to operate at variable speeds whereas following pre-specified periodic trajectories and rejecting/reducing periodic fluctuations. For example, a two-degree-of-freedom control configuration for a novel omnidirectional wheelchair is proposed in [1]; an obstacle avoidance control for a two wheeled mobile robot based on an improved support vector regression technique was introduced by [2]. A category of motion systems is rotary system, which features a typical repetitive operation. The rotary components within a rotary system will return to the same angular position after revolving integer cycles or revolutions. An immediate impact is that most uncertainties (disturbances or unknown parameters) are position-invariant (as opposed to time-invariant) and become spatially periodic with respect to the angular position. Note that such periodicity is invariant to the operating speed of the system.

The increasing complexity in architecture and the high-performance requirement of recent motion systems have posed major challenge on conceiving and synthesizing a desirable control algorithm. Various types of temporal-based motion control algorithms have been developed for decades. Adaptive control [3-6] is capable of dealing with systems subject to unknown but time-invariant parameters. Iterative learning control [7-12], on the other hand, has been applied to systems subject to periodic disturbances or required to