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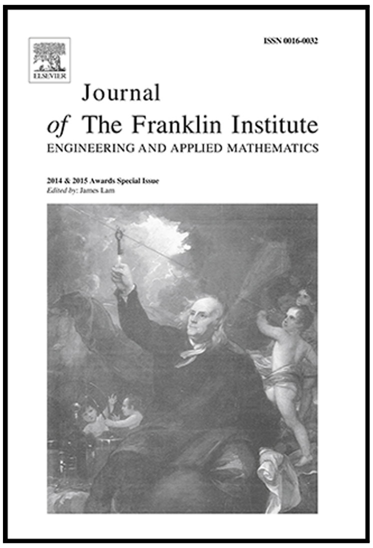

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Terminal Iterative Learning Control for Discrete-Time Nonlinear System Based on Neural Network☆

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Abstract

The terminal iterative learning control (TILC) is designed for nonlinear system based on neural network. A terminal output tracking error model is obtained by using a system input and output algebraic function as well as the differential mean value theorem. Radial basis function (RBF) neural network is utilized to construct the input for the system. The weights are updated by optimizing an objective function and an auxiliary error is introduced to compensate the approximation error from neural network. Both time-invariant input case and time-varying input case are discussed in the note. Strict convergence of proposed algorithm is proved by Lyapunov like analysis. Simulations based on train station control problem and batch reactor are provided to demonstrate the effectiveness of the proposed algorithms.

Keywords: Iterative Learning Control, Neural Networks, Nonlinear System

1. Introduction

Iterative learning control (ILC) was first proposed by Arimoto in 1980s [1], which is applied to solve the tracking problem of a given task in finite time interval repeatedly. Since then, ILC has attracted a lot of attention due to its simple structure and effective performance. A detailed review was given in [2] from both theoretical and practical perspectives, including a categorization on ILC research from 1998 to 2004. The review article [3] presented a unified formulation of ILC, repetitive control and run-to-run control, also analyzed the similarities and differences.

The conventional ILC is designed to track the entire trajectory in a given time interval. However, in many practical scenarios, maybe only the terminal point of the output is claimed to be accurately tracked. As an example, taking the basketball shooting from a fixed position into consideration, the player only cares whether the basketball hits the basket, rather than whether the basketball follows some appointed trajectory. Another illustration is the train operation where the driver expects better accuracy on the arrival position than the train running process among stations. There are two primary characteristics in such kind of systems. The first is that only the last state or output is measured, thus only the tracking error at the last position can be used for updating the input signal. The other is that only the terminal state or output instead of the whole trajectory is selected as the control objective. ILC designed for these systems is called terminal ILC (TILC).

After TILC was applied in RTPCVD (rapid thermal processing chemical vapor deposition) thickness control [4], it has been extensively exploited. The train stop control is a typical terminal control where only the final train stop position is of major concern. The TILC was introduced to utilize the terminal stop position error in previous braking process to update the control profile [5]. Data-driven method has shown its effectiveness in TILC. A data-driven optimal TILC approach was provided in [6] for both linear and nonlinear discrete-time systems. Detailed proofs

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