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INTELLIGENT CONTROL OF MECHANICAL SYSTEMS WITH RANDOM FRICTION

Hyun Cheol Cho[1], M. Sami Fadali[2] and Kwon Soon Lee[1,*]

[1]Department of Electrical Engineering
Dong-A University
840 Hadan 2-dong, Saha-gu, Busan 604-714, Korea
hyunccho@gmail.com; kslee@dau.ac.kr
*Corresponding author

[2]Department of Electrical Engineering
University of Nevada-Reno
Reno, NV 89557, USA
fadali@unr.edu

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Abstract. *In this paper, we propose a neural network control of nonlinear mechanical systems with stochastic friction, which is a practical dynamic characteristic of real-time mechanical experiments. An adaptive observer is designed using windowing Least Square (LS) estimation to represent time-varying friction dynamics and compensate for the approximation error due to discretizing the nonlinear system. We construct a recurrent neural control for position tracking of mechanical systems. Its weights are partially updated using an online learning procedure to compensate for system perturbation. We conduct computer simulations to evaluate our control algorithm and compare it to Proportional Integral Derivative (PID) control.*
Keywords: Mechanical systems, Neural network control, Stochastic friction

1. **Introduction.** Mechanical friction in dynamic systems significantly influences the performance of control systems. Engineers usually model friction dynamics mathematically and analytically design compensators to counter the effects of friction.

In [1], Lee et al. used sliding mode control for robust adaptive tracking control of 1 DOF mechanical systems with stick-slip friction. Canudas-de-Wit and Lischinsky in [2] modeled the dynamic friction of a DC motor servomechanism, which is only partially known to the designer. In [3], the authors designed a continuous dynamic controller for nonlinear systems with a bristle friction model and provided sufficient conditions for global stabilization by estimation of bristle deflection. Vedagarbha et al. in [4] presented three observers to estimate unmeasurable friction in mechanical systems based on different transient response characteristics for composite closed-loop systems. They designed two adaptive controllers which use a nonlinear observer/filter structure for asymptotic position tracking.

Recent research has focused on complex mechanical systems with friction such as: robot manipulators [5], precision positioning mechanisms [6], and flexible mechanical systems [7]. In [8], gain-scheduling controllers were proposed for servo-positioning systems and in [9] iterative learning control was applied to cope with friction, disturbance, and noise dynamics in servo control systems. Additionally, neural networks have been utilized to adaptively represent unknown friction dynamics of mechanical servos [10-14].