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ADAPTIVE NONLINEAR FEEDBACK DESIGN FOR CHAOS SUPPRESSION AND REGULATION IN UNCERTAIN UNIFIED CHAOTIC SYSTEM

M. Ataei* and F. Haghighatdar

Department of Electrical Engineering, Faculty of Engineering
University of Isfahan
Hezar-Jerib St., Isfahan 8174673441, Iran
haghighat@ui.ac.ir
*Corresponding author: ataei@eng.ui.ac.ir

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Abstract. *In this paper, an adaptive method for chaos suppression and regulation in uncertain unified chaotic system is proposed. For this purpose, at the first step, an adaptive non-linear state feedback is designed to suppress the chaotic behavior of under consideration system. In this way, the Lyapunov's direct method is used to select the appropriate adaptive non-linear state feedback. The asymptotic stability guarantee of uncertain unified chaotic system using non-linear feedback controller, in a stochastic point on the general manifold of its equilibrium points, is proved in a lemma. At the second step, a combination of suggested adaptive non-linear state feedback and linear feedbacks, with constant and adaptive gains, is used to regulate the controlled system at the desired set-point placed on the general related equilibrium manifold. In this stage, the asymptotic stability of the controlled system on the desired set-point is proved in another lemma using the Lyapunov's indirect method. Finally, simulation results of applying the controllers to uncertain unified chaotic system for different cases are provided to show the well-acceptable performance of the proposed controllers.*
Keywords: Adaptive control, Unified chaotic system, Lyapunov's stability theory, Chaos suppression, Regulation

1. **Introduction.** Chaotic phenomena have been observed in numerous systems in physics, chemistry, biology, ecology and engineering. But, they have been elapsed only about a few more than four decades from the first studies on the strange changes in the atmosphere by Lorenz [1], which can be considered as the first study in the field of chaotic phenomena. In 1990, according to the fact that there were infinite unstable cycle orbits embedded in the strange attractors of chaotic systems, Ott, Grebogy and York, proposed a control strategy, using chaos inherent characteristics, i.e., OGY method [2]. Theoretical investigation and control of chaotic systems, has been engaged the interest of many authors and researchers because of its wide potential applications in engineering sciences. For example, it has been shown that a permanent magnet synchronous machine (PMSM) experiences chaotic behavior for a certain range of its parameters [3] and since the performance of the PMSM degrades in this case chaos should be suppressed [4]. Also, it has been found that nonlinear behavior of some systems can be studied through chaotic models. For instance, DC arc furnaces which are applied in large industrial systems and represent one of the major sources of perturbations for the feeding system are modeled using three well-known chaotic attractors (Rössler, Chua and Lorenz attractors) [5]. Moreover, chaos synchronization which has a vital role in secure communication can be performed by using unified chaotic systems as the master and slave system [6].