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A NEW ROBUST ADAPTIVE CONTROL SCHEME FOR NON-AFFINE NONLINEAR SYSTEMS BASED ON SHLNN DISTURBANCE OBSERVER

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Abstract. *A novel adaptive online learning control scheme called single hidden layer neural networks disturbance observer (SHLNNDO) is developed for a class of uncertain non-affine nonlinear systems. In this paper, the term "disturbance" refers to the combination of model uncertainties and external disturbances. A general approach is provided for using SHLNNDO to enhance disturbance attenuation and robustness of current linear or nonlinear control methods. By Lyapunov's direct method, a rigorous poof shows that the SHLNNDO can approximate the effects of the disturbances arbitrarily closely. As a demonstration of the application of the approach, a new robust adaptive feedback linearization control (RAFLC) algorithm is proposed by integrating the existing feedback linearization control (FLC) method with the SHLNNDO technique. Conditions are derived which guarantee ultimate boundedness of all the errors in the combined system. Excellent disturbance attenuation ability and strong robustness of the proposed RAFLC method are shown by a numerical example.*
Keywords: Nonlinear systems, Adaptive control, Neural networks, Disturbance Observer

1. **Introduction.** The problem of controlling uncertain nonlinear systems has received much attention in control community. A typical technique is to use an estimator to approximate the uncertainties, and then effective controllers can be designed based on the approximations. See [1,2] and references therein. Currently, the most common function estimators are artificial neural networks (ANN) and fuzzy logic structures (FLS), due to their universal approximation, learning, and adaptation abilities [3-8]. An implicit assumption is that the parameters of ANN and FLS change more slowly than the states in the plant. Such an assumption may not be met in some practical applications. Disturbance observer (DO) is another popular approach to estimate the effects of system uncertainties, and it has been developed and applied in many industrial issues very successfully quite some time [10-16]. However, DO does not possess the capability of online learning like ANN and FLS. Most of the existing work in DO is mostly heuristic, and lacks adequate theoretical rigor and analysis [16].

Recent work has been concentrated on the development of new estimators with faster convergence speed and higher approximation precision. In [17], the authors extend the