AN IMPROVED PERFORMANCE ADAPTIVE CONTROL METHOD FOR LINEAR AND LINEARIZABLE SYSTEMS

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EXTENDED ABSTRACT

Since the first rigorous proofs of asymptotically stable adaptive control methods for linear systems [1-3], many different design methods have been developed [4-20, 23]. In [5, 11-13], the issue of controller performance was addressed by using sufficiently rich reference inputs, under the presence of which, exponential convergence of the tracking and parameter errors to zero is guaranteed. However, this improvement in convergence results in a poorer transient performance if the desired reference trajectories are not sufficiently rich. Furthermore, since the exponential convergence is not uniform, the rate of convergence can be very small, so that large transients may still occur, especially in the case of large initial parameter uncertainty. In [14], a high-gain switching adaptive controller for linear systems which provides an "arbitrarily good transient and steady-state performance" was introduced. The result of [14] is important since it provides the necessary theoretical justification for the quest of practically realizable adaptive controllers with improved performance characteristics. The stability and convergence results of [1-12, 15] provide little or no information about the transient behavior of the system, allowing for unpredictably large overshoots, bursts, and low convergence rates, especially in the presence of large initial parameter uncertainty.

The design of adaptive controllers with improved transient performance is, therefore, a problem of particular interest at the present stage of adaptive control. Successful designs of adaptive controls with quantifiable transient behavior for linear systems have been introduced in [16-20] and [22-25]. In [18-19], performance improvement requires the knowledge of the high frequency gain k_p of the plant. This requirement was relaxed in [22-23] and later in [20], where similar performance improvement results under some (not arbitrary) uncertainty on k_p were obtained. In this paper we extend our previous results [21-23], as well as those of [16-20], achieving improved performance adaptive control (IPAC) for linear systems under the "standard" MRAC assumption about the high frequency gain of the plant k_p, i.e. knowledge of the sign and that of an upper bound. The previous approach can be applied to a class of nonlinear systems, i.e. that of feedback-linearizable systems [26, 27] resulting in similar performance improvement properties. Currently, our research is focused on augmenting the above class of nonlinear systems within which the design of smooth adaptive controls achieving improved performance is possible.

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