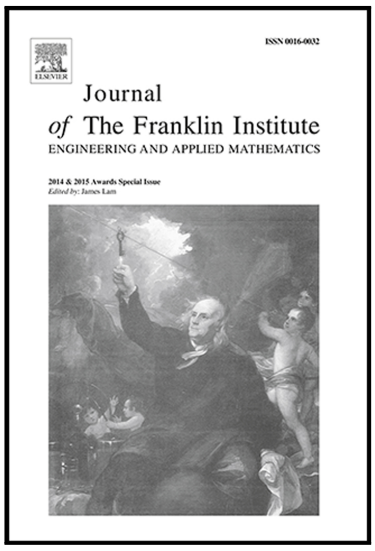

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Anti-disturbance Control Based on Disturbance Observer for Nonlinear Systems with Bounded Disturbances

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Abstract

A composite anti-disturbance control problem for a class of nonlinear systems is studied in this paper. There are two types of disturbances in the systems, one is the matched disturbance with bounded variation rate, the other is the unmatched time-varying disturbances. A nonlinear disturbance observer is designed to estimate the matched disturbances, which can be presented separately from the controller design. By integrating DOBC with back-stepping method, a composite DOBC and back-stepping controller is proposed, and the disturbance estimations are introduced into the design of virtual control laws to compensate the unmatched disturbances. In addition, it is proved that all the states in the closed-loop system are uniformly ultimate bounded (UUB). Finally, a numerical example is given to demonstrate the feasibility and effectiveness of the proposed method.

KEY WORDS: Nonlinear systems; Bounded disturbance; Nonlinear disturbance observer; Anti-disturbance control.

1 Introduction

Duing to the widespread existence of disturbance, the problem of anti-disturbance control has been an important topic in the control theory[1−10]. In accordance with the capability of anti-disturbance, the control method can be divided into two types. The first one is disturbance attenuation method, such as nonlinear H_∞ control, sliding mode control, stochastic control theory and etc. The second one is disturbance rejection method, including nonlinear output regulation theory, extended state observe(ESO), active disturbance rejection control(ADRC) and disturbance observer-based control (DOBC).

In the late of 1980s, disturbance observer-based control (DOBC) was proposed by Nakao et al. Its principle is to estimate the disturbance by the disturbance observer, then the disturbance is compensated in the feed-forward channel by its estimation, so as to achieve the satisfactory system performance. Recently, DOBC schemes have been applied into various practical systems, such as robotic systems [11], table drive systems [12], high speed direct-drive positioning tables [13] and magnetic hard drive servo systems[14]. Up to now, more and more research results on DOBC have been put forward by scholars [15−20]. In [16-17], the nonlinear disturbance observer was constructed to estimate the external disturbances, which was generated by a linear exogenous system. In [18-19], the nonlinear disturbance observer was designed to

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