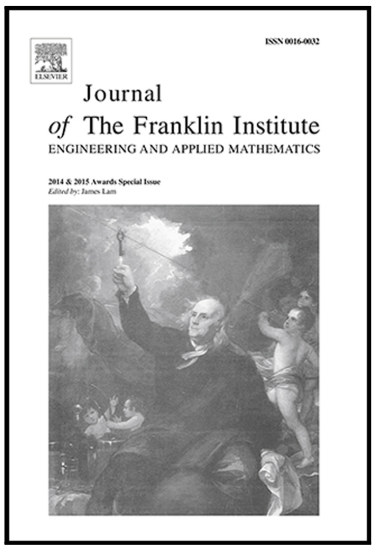

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Abstract

This paper presents a novel continuous fixed-time convergent control law for dynamic systems in the presence of unbounded disturbances. A continuous fixed-time convergent control is designed to drive all states of a multi-dimensional integrator chain at the origin for a finite pre-established (fixed) time, using a scalar input. The fixed-time convergence is established and the uniform upper bound of the settling time is computed. The designed control algorithm is applied to fixed-time stabilization of two mechatronic systems, a cart inverted pendulum and a single machine infinite bus turbo generator with main steam valve control.

I. Introduction

Nowadays, design of finite-time convergent control laws and estimation of their convergence (settling) times has become an attractive and popular research area. The first results yielding convergence time estimates for control algorithms in two-dimensional systems, such as twisting [1] and super-twisting [2], can be found in [3] and [4]. Convergence time estimates for the super-twisting algorithm were obtained in [5], [6], and [7], based on an explicit Lyapunov function or a geometric approach. Another challenging problem is to design a continuous control law driving system states at the origin for a finite pre-established (fixed) settling time. A generalization of the super-twisting algorithm resulting in fixed-time convergence was given in [8]. The consistent study of fixed-time convergent control laws was initiated in [9]. A comprehensive survey summarizing existing results on finite and fixed-time convergence can be found in [10]. However, a continuous fixed-time convergent control law is not yet known for a multi-dimensional integrator chain subject to unbounded disturbances.

The contribution of this paper is in designing a novel continuous fixed-time convergent control law for dynamic systems in the presence of unbounded disturbances. A critical advantage of the obtained continuous fixed-time convergent control law consists in assuring convergence of all system states to the origin for a fixed (pre-established finite) time for any initial condition, whereas a linear feedback or a control law using only terms with exponents less than one cannot guarantee this important feature: the corresponding convergence times are infinite or tend to infinity as initial conditions increase. The fixed-time convergence property means that the tracking problem for all system states can be solved for any unknown initial conditions for a pre-established (fixed) time. Furthermore, the obtained continuous fixed-time control is robust with respect to disturbances satisfying the Lipschitz condition, including unbounded ones. As already examined applications of continuous fixed-time convergent control laws, we can mention the DC motor stabilization problem treated in [11] and the angular rate commands tracking problem for an F-16 fighter [12]. In this paper, a continuous fixed-time convergent control is applied to stabilizing

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