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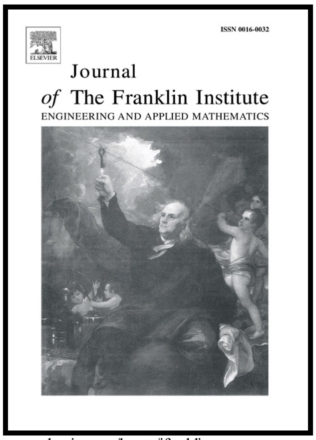

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Finite-time stabilization of a class of output-constrained nonlinear systems ⋆

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Abstract

This paper is concerned with the finite-time stabilization with output constraint for a class of uncertain nonlinear systems. The systems under consideration admit a structure which includes the one dominated by lower triangular form as a special case. We give some sufficient conditions that enable our design by characterizing the nonlinear functions of the considered systems. Based on the technique of adding one power integrator, both the finite-time stabilizers and the Barrier Lyapunov function are systematically constructed to guarantee finite-time stability of the closed-loop smooth switched system while the output constraint is not violated in a domain. An example is provided to demonstrate the effectiveness of the proposed result.

Key words: nonlinear systems; finite-time stabilization; output constraint; adding one power integrator; Barrier Lyapunov function.

1 Introduction

The finite-time stabilization is one of the most important problems of finite-time control and has drawn an increasing attention in recent years [1,12,13,22,31,36,41] because the finite-time stabilized systems usually practically demonstrate some desired features such as faster convergence rates, higher accuracies, and better disturbance rejection properties [4,5,25]. Due to these significant advantages, the finite-time control has been widely applied in engineering, for example, multi-agent systems[25], spacecraft systems[10], electrostatic microactuators[16], circuit system[37]. Lyapunov stability theorem for finite-time stability analysis of nonlinear systems was proposed in [4], which is a basic tool for synthesis of nonlinear control systems. For example, [15,17,19,35] achieved the finite-time stabilization for several classes of nonlinear systems by combining the finite-time stability with backstepping or adding one power integrator. [18] studied the adaptive finite-time control for uncertain nonlinear systems. [11] designed a bounded controller to finite-time stabilize a class of nonlinear systems. [20] developed an output feedback controller to finite-time stabilize a class of nonlinear systems. The finite-time stabilization is studied for a class of nonlinear cascaded systems in [8]. [14,26] investigated the global finite-time stabilization for a class of switched nonlinear systems. It is worth pointing out that many systems in practical have states/output constraints. So, it is of great significance to consider these constraints when design controller. Unfortunately, these constraints are not taken into account in the aforementioned papers.

On the other hand, due to the physical constraint and safety specifications, constraints need to be taken into account in controller design. This is because the violation of the constraints during operation may result in performance degradation, hazards or system damage [9]. So far, various approaches have been proposed to study the constraint control [3,6,30]. It is worth noting that a typical and useful system structure plays an important role in studying constraint control. It is well known that the strict-feedback form is a typical structure, which and whose variants have been extensively studied over the past two decades (see, for example, [6,7,21,23,24,28,29,34,38–40] and references therein). For a class of strict-feedback nonlinear systems, non-overshooting tracking problems were investigated in [23] by backstepping. By transformation technique, [9]

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