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Robust Stabilization of Fractional-Order Uncertain Systems with Multiple Delays in State

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Abstract: In this paper, a sliding mode control law is designed for stabilization of specific class of linear systems of fractional order despite of multi delays in the state system. A fractional order sliding surface is proposed, and using the variable structure control theorem, control law is introduced. A numerical simulation is given to show the effectiveness of the proposed design approach.

Keywords: *sliding mode control (SMC); Lyapunov stability analysis; fractional order system.*

Mathematics Subject Classification (2010): 93C35, 93D05, 93D15.

1 Introduction

Recently, time delays inevitably exist in systems and processes [1, 2] due to poor performance, undesirable system transient responses, and instabilities so that as a result, most systems may include a delay term. In general, the time-delay is believed to have a negative impact on the control system performance. To compensate for this impact, Smith predictor schemes work fine for slow processes [3, 4]. In the last two decades, the theory of fractional calculus has attracted researchers [5–9], because of its wide use in different areas of sciences and engineering, such as viscoelastic systems [12,13], sinusoidal oscillators [14], electromagnetic theory [15,16], and bioengineering [17]. The sliding mode control (SMC) approach is one of the most important methods and this approach can be used in many systems [18, 19] because of its robustness to parameter uncertainties and insensitivity to external disturbances. Sliding mode control (SMC) is based on the theory of variable structure systems [20]. The main feature of SMC is to cause states from initial

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