Characterization of predefined-time stability and its application using non-singular sliding mode control

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Abstract

This work presents a Lyapunov-like characterization for predefined-time stability (P_DTS) of a class of dynamical system. The proposed Lyapunov-like condition is shown to be a generalization of the prior results on P_DTS. Based on the proposed scheme, non-singular predefined-time controllers are designed for the first and second-order systems. Further, a non-singular predefined-time terminal sliding mode (NP_DTSM) surface has also been put forward for the second-order system. A few advantages of these designed controllers are: i) The control scheme can withstand the effects of bounded external disturbances as well as internal disturbances and is non-singular in the whole state space. ii) The convergence time can be bounded by a constant defined by the user in advance. Along with the predefined-time synchronization of the Φ^6 duffing oscillator, which is a two-dimensional chaotic system, few more examples are provided to justify the numerical inferences of the proposed scheme.

Keywords: Predefined-time stability, Lyapunov approach, Non-singular predefined-time terminal sliding mode control, Synchronization.

Results and discussion

(1) A Lyapunov-like theorem on P_DTS is proposed .
(2) The convergence time is independent of the initial conditions and also the upper bound of the settling time can be defined in advance by the user under the present scheme.
(3) The aforementioned theorem can be considered as a generalization of previously many predefined-time stability theorems discussed in ([1, 2, 3]).
(4) A non-singular predefined-time sliding mode manifold is constructed for second-order systems.
(5) Two robust non-singular predefined-time controllers are modeled for stability of first and second-order systems.
(6) Several numerical simulations are provided to demonstrate the reliability and feasibility of the control criteria.

References

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