ROBUST FIXED-TIME CONTROL OF EULER-LAGRANGE SYSTEMS

Abstract

Fixed-time control has emerged as an effective framework for nonlinear systems requiring fast and predictable convergence, as it guarantees convergence within a prescribed time bound independent of initial conditions. This thesis develops fixed-time control frameworks for Euler–Lagrange systems, with emphasis on non-singular control design, robustness against uncertainties, and practical implementability. Existing fixed-time approaches often suffer from structural singularities, increased closed-loop order due to auxiliary filters or observers, discontinuous sliding manifolds, and limited experimental validation. To address these issues, this work establishes fixed-time convergence using Lyapunov-based analysis and level-set arguments, yielding explicit settling-time bounds independent of initial conditions while preserving the original system order. The framework is further extended to robust sliding mode control for uncertain systems and to an event-triggered implementation that reduces computational and communication requirements while ensuring Zeno-free operation and fixed-time practical stability. The effectiveness of the proposed controllers is demonstrated through numerical simulations and real-time experiments on representative mechatronic platforms, including a single-link manipulator, and a two-degree-of-freedom helicopter. The results demonstrate that the proposed methods achieve robust, predictable, and practically implementable fixed-time control for nonlinear Euler–Lagrange systems.