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An Observer-Based Direct Adaptive Fuzzy Sliding Control with Adjustable Membership Functions

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Abstract : In this paper, an observer-based direct adaptive fuzzy sliding mode (OAFSM) algorithm is proposed. In the proposed algorithm, the zero-input dynamics of the plant could be unknown. The input connection matrix is used to combine the sliding surfaces of individual subsystems, and an adaptive fuzzy algorithm is used to estimate an equivalent sliding mode control input directly. The fuzzy membership functions, which were determined by time consuming try and error processes in previous works, are adjusted by adaptive algorithms. The other advantage of the proposed controller is that the input gain matrix is not limited to be diagonal, i.e. the plant could be over/under actuated provided that controllability and observability are preserved. An observer is constructed to directly estimate the state tracking error, and the nonlinear part of the observer is constructed by an adaptive fuzzy algorithm. The main advantage of the proposed observer is that, the measured outputs is not limited to the first entry of a canonical-form state vector. The closed-loop stability of the proposed method is proved using a Lyapunov-based approach. The proposed method is applied numerically on a multi-link robot manipulator, which verifies the performance of the closed-loop control. Moreover, the performance of the proposed algorithm is compared with some conventional control algorithms.

Keywords : adaptive algorithm, fuzzy systems, membership functions, observer
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