

Research on fuzzy control based on hedge algebra and its application to MISO model control

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Abstract: This study presents a novel fuzzy control approach based on hedge algebras (HA) for multi-input single-output (MISO) systems. Traditional fuzzy logic controllers often rely on heuristic rule bases and membership functions, which can lead to semantic inconsistencies and suboptimal performance. To address these limitations, the proposed method leverages the algebraic structure of hedge algebras to formalize linguistic hedges and semantically quantify linguistic terms, enabling a more rigorous and interpretable rule base construction. A systematic design procedure is developed to map expert knowledge into an HA-based control structure, eliminating the need for exhaustive tuning of membership functions. The controller is applied to a representative MISO nonlinear model to evaluate its effectiveness. Simulation results demonstrate that the proposed HA-based fuzzy controller achieves superior tracking accuracy, faster response times, and enhanced robustness against parameter variations compared to conventional fuzzy logic controllers. The findings confirm that integrating hedge algebra theory provides a systematic and efficient framework for designing high-performance fuzzy controllers for complex MISO systems, with significant potential for practical industrial applications.

Keywords: fuzzy control, hedge algebra, MISO system, control application