

Application of fuzzy rule-based system for temperature furnace control using subtractive clustering of data

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Abstract: This study presents a fuzzy rule-based control system for thermal furnaces, utilizing subtractive clustering for data-driven rule extraction. Traditional control methods often struggle with the nonlinearities, time delays, and parameter uncertainties inherent in thermal processes. To address these challenges, this research proposes a methodology that automatically generates a compact and interpretable fuzzy rule base from input-output operational data. Subtractive clustering is employed to identify the optimal number of clusters and their centers, which directly define the antecedent membership functions and the consequent parameters of the fuzzy system. The resulting fuzzy logic controller is then applied to regulate the furnace temperature. Simulation and experimental results demonstrate that the proposed controller achieves superior performance in terms of setpoint tracking, disturbance rejection, and robustness compared to conventional PID controllers. The data-driven approach significantly reduces the reliance on expert knowledge for rule definition, while the fuzzy framework effectively handles system nonlinearities. This work provides an efficient and practical solution for intelligent temperature control in industrial thermal applications.

Keywords: Fuzzy logic, Fuzzy clustering, Subtractive clustering, Temperature control