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FUZZY LOGIC CONTROLLER WITH INTERVAL-VALUED INFERENCE FOR DISTRIBUTED PARAMETER SYSTEM

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Abstract. *A fuzzy logic controller with interval-valued inference mechanism is presented for the control of distributed parameter system (DPS). Interval-valued fuzzy set, a special case of type-2 fuzzy set, is innovatively designed to cope with the spatial information of distributed parameter system. The proposed fuzzy logic controller is composed of six modules: fuzzifier, fuzzy composition, rules, inference engine, type-reducer, and defuzzifier. The fuzzy composition maps actual spatial information to an interval-valued fuzzy set - the fuzzy information that the FLC can identify, and then the interval-valued rule inference operates on the interval-valued fuzzy set that contains spatial information and produces control action. The application of the FLC with interval-valued inference to a catalytic reactor demonstrates its effectiveness to a class of distributed parameter systems. Compared with the ordinary FLC, the proposed FLC can improve its control performance due to its spatial expression and interval-valued inference mechanism.*
Keywords: Interval-valued fuzzy set, Fuzzy logic controller, Distributed parameter system, Fuzzy set, Type-2 fuzzy set

1. **Introduction.** In the real world, most physical processes are inherently characterized by the presence of strong spatial variations [1], and are usually called as distributed parameter systems. The mathematical models describing these distributed processes are represented by partial differential equations and the control problems will involve the regulation by using spatially-distributed control actuators and measurement sensors. Most of control methods for distributed parameter systems are based on mathematical model. There exist two approaches to control distributed parameter systems. The first one is to control a distributed parameter system using conventional control method based on 'lumped' system model (called as 'early lumping' in [2]), i.e. simply discretizing the partial differential equation by using the finite-difference or finite-element techniques and leading to a approximate system of thousands of ordinary differential equations. The other one is to control a distributed parameter system by fully utilizing control theory of distributed parameter systems (called as 'late lumping' in [2]), requiring plenty of complex mathematical knowledge.

Most fuzzy controls [3-5] in the real world are also found to be designed on lumped systems. There are fewer literatures devoted to the fuzzy controls for distributed parameter systems. In [6-8], the fuzzy control designs were based on exact mathematical models of distributed parameter systems under the structure of the control theory of distributed