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ADAPTIVE FUZZY BACKSTEPPING FAULT-TOLERANT CONTROL FOR UNCERTAIN NONLINEAR SYSTEMS BASED ON DYNAMIC SURFACE

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Abstract. *An adaptive fuzzy fault-tolerant control design scheme for a class of perturbed and strict feedback nonlinear systems with actuators faults is proposed. The fuzzy logic systems are used to approximate to the nonlinear functions and the fault functions of systems. The continuous robust term is adopted to minimize the influence of modeling error or disturbance. Meanwhile, the dynamic surface control technique is incorporated into the backstepping design framework, therefore, the "explosion of complexity" problem is avoided. It is proved that the closed-loop system is semi-global uniformly ultimately bounded, with tracking error converging to a residual set in the presence of the faults. Simulation results demonstrate the effectiveness of the proposed approach.*
Keywords: Adaptive fuzzy control, Dynamic surface control, Backstepping, Nonlinear systems, Robust fault-tolerant

1. **Introduction.** In the past decade, fuzzy control has been successfully employed for solving many nonlinear control problems. A significant feature of the fuzzy control is the use of the linguistic fuzzy control rules in the controllers. However, it is more than often that fuzzy rules are difficult to obtain, especially for complicated systems. With the desire of obtaining fuzzy control rules systematically, a learning control scheme, termed as the adaptive fuzzy control, has been proposed in the literature [1]. Afterwards, various adaptive fuzzy control approaches have been reported by making use of the fuzzy approximation theories, Lyapunov stable theory, robust technique, feedback linearization control technique [2-6], and backstepinng control technique [7-12]. Generally, the adaptive fuzzy control approaches can deal with the uncertain nonlinear systems which do not require the linearity-in-the parameter assumption, and obtain the good control performance. It is due to these properties that fuzzy adaptive control has been attracted more attention in the fuzzy control fields in the last few years.

To improve system reliability and security, fault tolerant control strategy has received increasing attention and has been applied in the nonlinear fault diagnosis and fault-tolerant control. Recently, motivated by adaptive fuzzy control approaches and stability analysis, there are some results about fuzzy fault controllers [13-15]. References [13] and [14] used fuzzy logic systems to approximate the unknown functions in the plant and developed an adaptive fuzzy fault tolerant control for a class of SISO unknown nonlinear systems, and it was applied to compensate for actuator failures in a turbine engine. Reference [15] developed an adaptive fuzzy approach for fault accommodation based on the idea of a corrective law which activated in the presence of the faults, in which fuzzy logic systems are used to approximate the unknown functions and learn the unknown