Type-2 Fuzzy Modeling and Control of Nonlinear Steer-by-Wire Systems With Actuator Fault and Event-Triggered Communication

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Abstract

This paper proposes the adaptive fuzzy modeling and control method for steer-by-wire (SbW) systems with uncertain nonlinearity, time-varying disturbance, actuator fault, and event-triggered communication. First, the adaptive interval type-2 fuzzy logic system (IT2 FLS) is developed to modeling the uncertain nonlinearity of SbW systems. The Lyapunov-based adaptive law can guarantee the modeling performance of IT2 FLS. Then, considering the limited communication channel bandwidth of the controller-area-network (CAN), the time-varying disturbance, and actuator fault of SbW systems, an event-triggered sliding mode control is proposed for SbW systems. The chattering phenomenon of the sliding mode control system can be eliminated by using the nested adaptive technology. Theoretical analysis shows that the practical finite-time stability of the closed-loop system can be achieved while avoiding the Zeno-behavior. Finally, numerical simulations and vehicle experiments are given to evaluate the effectiveness of the proposed methods.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

(a) Schematic diagram of the SbW system

(b) Physical diagram of the SbW system

Figure 1

Schematic diagram of the SbW system.

Figure 2

Various elements of T2 FS and IT2 FS.

Figure 3

The Schematic of the adaptive IT2 fuzzy modeling and control of SbW systems.

Figure 4

The structure of IT2 FLS.

Figure 5

Control performance in the simulation.

(a) Schematic diagram of the experiment platform

(b) Physical diagram of experiment platform

Figure 6

The experiment platform of SbW systems.

(a) Tracking performance

(b) Tracking error $y - y_d$

(c) Control signal u

(d) Inter-event interval

Figure 7

Control performance in the experiment.