Fixed-Time Fault-tolerant Control for Nonlinear Multi-Agent Systems with Sensor and Actuator Faults

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Abstract—**In this paper, the problem of nonlinear MASs with sensor faults and actuator faults is studied in depth. In practical applications, sensors and actuators are the important part of the systems, and the performance of the system also depends heavily on the feedback of sensors and the application of actuators, so the fault-tolerant control of sensor faults and actuator faults has also attracted the attention of researchers. Based on the backstepping method and the support of Lyapunov stability theory, this paper proposes a new type of fixed-time fault-tolerant control scheme based on the properties of fuzzy logic systems, and the upper bound of the convergence time of the fixed-time control method adopted in this scheme will no longer depend on the initial value of the system state, which has higher applicability and practical significance. The fault-tolerant control scheme proposed in this paper effectively solves the problem of consistent tracking control of MASs with sensor faults and actuator faults. In the design process based on the backstepping method in this paper, we first use the characteristics of the fuzzy logic system (FLS) to solve the design difficulties caused by the unknown nonlinear functions by approximating unknown nonlinear functions. In this process, we introduce a fault compensation signal, which can compensate for the fault effect caused by the sensor and effectively ensure the stability of the system. Secondly, the problems of "singularity" and "computational complexity" in the fixed time control based on the traditional backstepping method are avoided by introducing the command filtering technology, Then, the uncertainty of the control direction of the actuator is solved by combining with the properties of the Nussbaum function, and the effectiveness of the control strategy is ensured. Finally, it is proved that the output of all followers and leaders in the closed-loop system is consistent for a fixed-time by designing suitable parameters. Therefore, it can be concluded that the controller designed in this paper can suppress the influence of sensor failure and actuator failure on MASs information interaction and improves the safety of the system. At the same time, the upper bound of the convergence time of the designed control scheme is only related to the design parameters, it has nothing to do with the initial conditions of the system state. Finally, a mathematical simulation example is used to verify the effectiveness of the fixed-time fault-tolerant control proposed in this paper, that is, it effectively reduces the impact of actuator failure and sensor failure on system performance and achieves the control goal of the system studied in this paper.**

Keywords-multi-agent system; fault-tolerant control; consistency tracking; fixed- time