Consensus Control of the Multi-Agent Systems under both Disturbances and Noises*

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Abstract Consensus tracking control problem of the multi-agent systems with both noise and disturbances is studied in this paper. A robust adaptive control scheme is designed according to Lyapunov stability theory. The main contribution of this paper is that the consensus is realized in multi-agent systems with both noise and external disturbances. Numerical simulations are carried out for the proposed scheme to demonstrate the effectiveness of the control strategy proposed in this paper.

Keywords Multi-agent systems, consensus, numerical simulations

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1. Introduction

In the era of big data, how to realize consensus in multi-agent systems has caused wide concern due to wide applications of multi-agent systems in unmanned aerial vehicles, mobile robots, etc [1–4]. Adaptive consensus control of multi-agent systems with uncertainties is proposed in the paper [5]. Consensus problem of Brunovsky-type nonlinear multi-agent systems is studied in [6]. Neural network-based adaptive consensus control for a class of nonaffine nonlinear multi-agent systems is studied in [7]. Therefore, consensus problem in multi-agent systems is a very important research topic.

At the same time, event-triggered control is very important in control theory because it can balance limited bandwidth with control system performance compared to a periodic sampling control. The control signal is updated only at discrete

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time and the control input remains constant between events during event-triggered control [8–13].

Recently, event-triggered control of multi-agent systems has made good progress [14–20]. A particularly interesting topic is the leader-following consensus problem. Wang et al. [21] investigated the leader-following consensus problem in a class of multi-agent systems with directed communication topology. Liu and his collaborators [22] studied the leader-following attitude consensus problem of multiple rigid-body systems. In [23], the leader-following problem was investigated in the multi-agent system with unknown parameters and uncertain external disturbances. Garcia et al. [24] studied the consensus tracking control for uncertain multi-agent systems and proposed an adaptive event-triggered consensus control scheme.

However, the information exchange between multiple agents will be affected by noises from communication channels and external environment in the real world. So, it is important to study the multi-agent system with noises and switched topology [25–29].

Based on the above discussion, this paper generalizes the existing research results and further studies the consensus tracking of multi-agent systems with noises and external disturbances by means of event-triggered adaptive control.

The rest of this paper is organized as follows. Consensus tracking control problem of multi-agent system is described in Section 2. Main mathematical results are given in Section 3. Numerical simulations are performed in Section 4. Finally, conclusions are made in Section 5.

2. Problem description

The dynamical behavior of the leader is given by the equation

$$\dot{x}_1(t) = a_1 x_1(t) + r(t), \tag{2.1}$$

where $x_1 \in R$ is the leader agent with the initial value $x_1(0) = x_{10}$, $r(t) \in R$ is the input of leader agent, and $a_1 < 0$ is an unknown parameter. The input signal $r(t)$ is bounded, that is to say, there exists $\bar{r} > 0$, such that $|r(t)| \leq \bar{r}$ holds for all $t \geq 0$.

In the following, we will consider the $N - 1$ follower agents. The ith follower can be described by the following equation:

$$\dot{x}_i(t) = a_i x_i(t) + u_i(t) + \sigma_i(t), \tag{2.2}$$

where $i = 2, \ldots, N, x_i \in R$ represents agent i with the initial value $x_i(0) = x_{i0}$, $u_i(t) \in R$ is the control input and $\sigma_i(t) \in R$ is an unknown disturbance factor. Let $\sigma(t) = [\sigma_2(t) \ldots \sigma_N(t)]^{\mathrm{T}}$ and it is assumed that there exists a constant $\bar{\sigma} > 0$ such that $\|\sigma(t)\|_\infty \leq \bar{\sigma}$. In this paper, the infinite norm is used, and the subscript ∞ will be omitted next to the norm operators unless it is necessary. It is assumed that parameters $a_i (i = 2, \ldots, N)$ are unknown. It is called non-identical or heterogeneous agent dynamics because each agent may have its own distinct dynamics.

In this paper, each agent i can only get its own states and it can transmit these states to agent j at some discrete time instants t_{ki} by using event-triggered strategies to schedule broadcasting instants and to reduce communication among agents. Fig. 1 gives a control block diagram of follower i.

Remark 2.1. It should be pointed out that the existing paper [24] considers the event-triggered consensus problem without noise and external disturbances, but