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Time-varying formation tracking for uncertain second-order nonlinear multi-agent systems

Key words: Multi-agent system; Time-varying formation; Formation tracking; Nonlinear dynamics; Extended state observer (ESO)

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Motivation

1. The formation control can find broad applications in many engineering fields. In some practical applications, the followers form the predefined time-varying formation when tracking the leader's trajectory.
2. In many studies on formation control of multi-agent systems, the dynamics of each agent are limited to be linear. However, most practical control systems are inherently nonlinear.

Method

1. The total uncertainty that lumps the unknown nonlinear dynamics and the external disturbance is regarded as an extended state of the agent.
2. An extended state observer (ESO) is designed to estimate the total uncertainty.
3. A novel ESO-based time-varying formation tracking protocol is proposed.

Major results

1. It is proved that, under the proposed protocol, the ESO estimation error and the time-varying formation tracking error can be made arbitrarily small.
2. An application in the target enclosing problem of multiple unmanned aerial vehicles (UAVs) verifies the effectiveness and superiority of the proposed approach.

Conclusions

1. The time-varying formation tracking problem for uncertain second-order nonlinear multi-agent systems has been studied. An ESO-based time-varying formation tracking protocol has been proposed.
2. The proposed approach provides a novel and practical solution to the time-varying formation tracking problem of multi-agent systems.
3. An application in the target enclosing of UAVs showed the effectiveness and superiority of the proposed approach.