Mao-de Yan, Xu Zhu, Xun-xun Zhang, Yao-hong Qu. Consensus-based three-dimensional multi-UAV formation control strategy with high precision. *Frontiers of Information Technology & Electronic Engineering*, **18**(7): 968-977.
http://dx.doi.org/10.1631/FITEE.1600004

Consensus-based three-dimensional multi-UAV formation control strategy with high precision

Key words: Multiple unmanned aerial vehicles; Consensus; Cooperative guidance; Cooperative control; Synchronization technology

Corresponding author: Xu Zhu
E-mail: zhuxu_1987@sina.com

ORCID: http://orcid.org/0000-0002-3616-4336

Motivation

- Traditional multi-UAV formation control methods have a major disadvantage that the communication topology between UAVs is rarely considered, so they cannot make full use of information flow and sharing.
- Most of the existing literature on consensus recognizes the UAV as a point mass, and Some scholars assumed that an automatic pilot operates in the inner loop and its executive capability is infinite. Both the above assumptions are too idealistic to be used in practice.
- The relationship between cooperative guidance and cooperative control is seldom studied.
- High control accuracy of the formation is needed through an effective and efficient way to reduce disturbances and measurement errors.

Main idea

- We focus on the multi-UAV formation control strategy using consensus with high precision.
- A cooperative guidance algorithm and a cooperative control algorithm are proposed and united.
- To improve the control accuracy of the formation, measurement errors in sensor data are reduced by synchronization technology.

Method

1. A second-order consensus algorithm is adopted to design the cooperative guidance system.
2. Feedback gains of the cooperative control law are selected by using the pole placement method (Liu and Tang, 2000).
3. To obtain the necessary and sufficient condition of the multi-UAV formation control strategy, state equations and matrix analysis are used.

Major results

- Both position and attitude achieve consensus and the team realizes stability

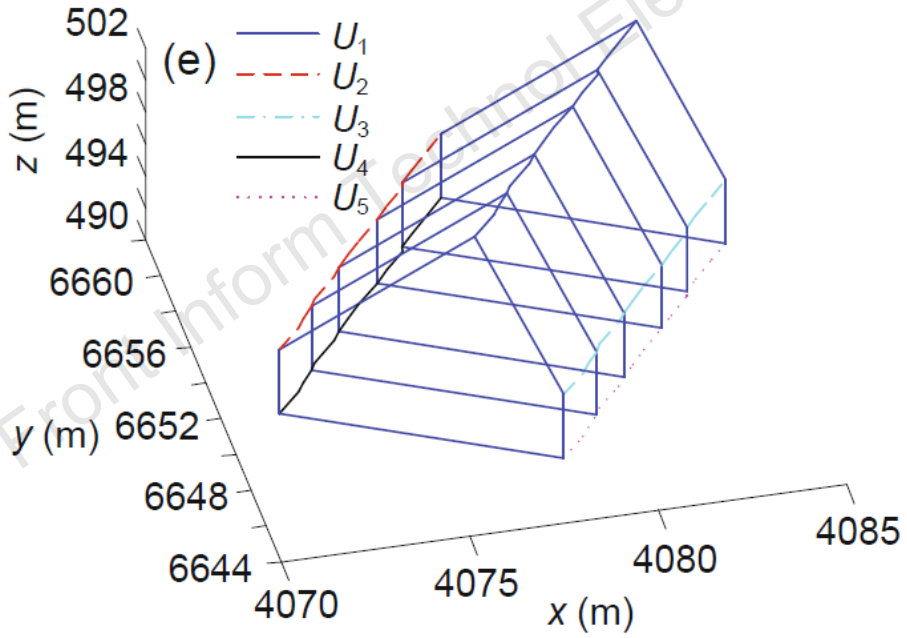

Fig. 5. Position and attitude of the formation.

Major results

- The effect of depressing measurement errors and synchronization errors with synchronization technology is better.

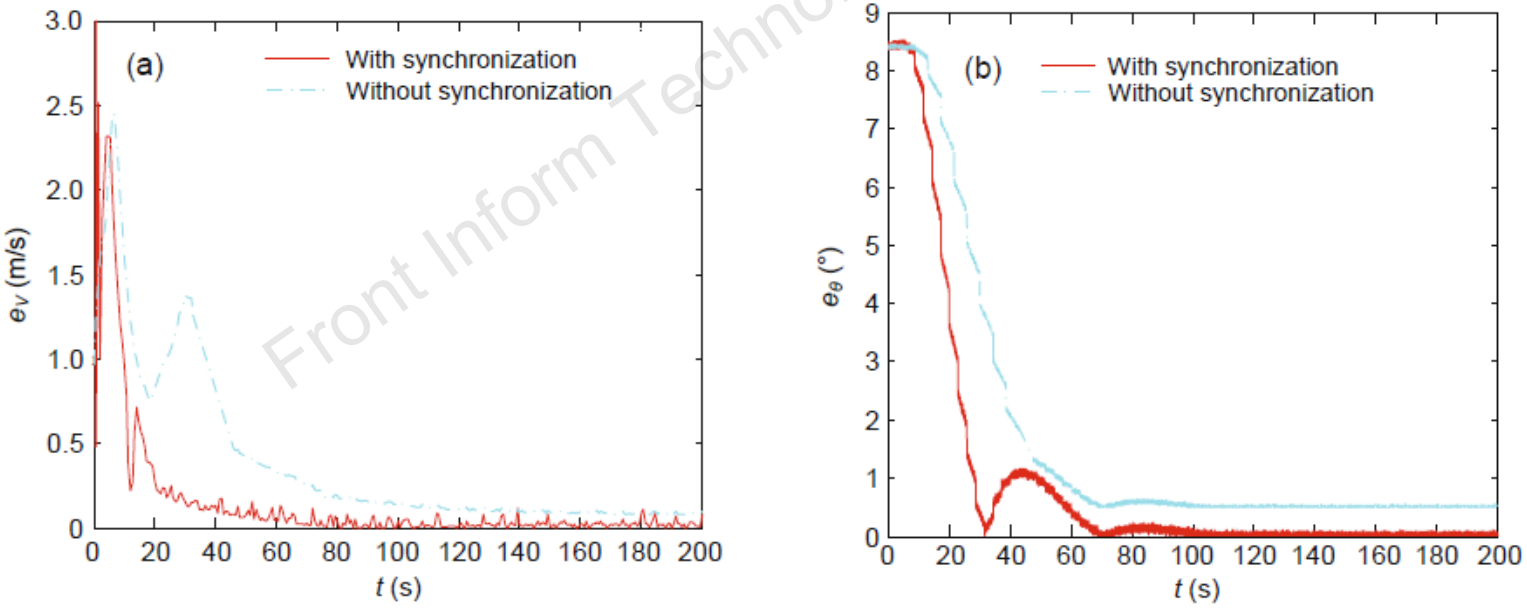

Fig. 7. Cross-coupled errors of the formation with and without synchronization technology.

Conclusions

- A multi-UAV formation control strategy with high precision is proposed based on second-order consensus.
- A cooperative guidance algorithm and a cooperative control algorithm are designed together to maintain a specified geometric configuration.
- Three-dimensional formation flight simulation shows that, by using the synchronization technology, both measurement errors and synchronization errors were driven to zero asymptotically.