IEEE ICUS 2022
Invited Session Summary

Title of Session

Navigation and Control of Swarm of Aerial Robots

Name, Salutation and Affiliation of Organizers

1. Assoc. Prof. Fei Gao

Zhejiang University, China

2. Assoc. Prof. Yongzhao Hua

Beihang University, China

3. Dr. Jianglong Yu

Beihang University, China

Biosketches of Organizers

Fei Gao is currently a tenure-track associate professor (doctoral supervisor) at the Department of Control Science and Engineering, Zhejiang University, where he works as the deputy-director and the technical leader of the Field Autonomous System and Computing (FAST) Laboratory, and leads the Flying Autonomous Robotics（FAR）group. He also works as PI for the Center of Autonomous Navigation of Swarm Robotics in Huzhou Institute, Zhejiang University. Fei Gao received his Ph.D. in Electronic and Computer Engineering from the Hong Kong University of Science and Technology in 2019. His research interests include aerial robots, autonomous navigation, motion planning, optimization, and localization and mapping. As the first or corresponding author, he has published over 40 prestigious papers in Robotics, including ICRA, IROS, ISER, ISRR, IEEE RAL, JFR, IEEE TRO, and Science Robotics. He is also the recipient of the IEEE-TRO 2020 King-Sun Fu Best Paper Award Honorable Mention, the IEEE-SSRR 2016 best paper award, and the IEEE/RSJ IROS 2021 best Application Paper Finalist. His research has been reported multiple times by mainstream technology media, such as IEEE Spectrum and Science. Fei Gao serves as associate editors for IET Cyber-systems and Robotics, and IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).

Yongzhao Hua received the B.E. and Ph.D. degrees in Navigation, Guidance and Control from Beihang University, Beijing, China in 2014 and 2019, respectively. From 2019 to 2020, he was a Postdoctoral Research Associate with Department of Aerospace Engineering, University of Bristol, Bristol, UK. He is currently an Associate Professor in Institute of Artificial Intelligence, Beihang University, Beijing, China. His current research interests include distributed control, optimization, and game for multi-agent systems. He was selected in the "Young Elite Scientists Sponsorship Program" by China Association for Science and Technology (CAST) in 2021.

Jianglong Yu received his bachelor and doctor degrees from the school of automation science and electrical engineering of Beijing University of Aeronautics and Astronautics in 2015 and 2020 respectively. At present, he is a postdoctor of Beijing University of Aeronautics and Astronautics and has been selected into the National Postdoctoral Program of Innovation Talents in 2020. His main research is the theory and application of cooperative guidance for aircraft swarm. A distributed cooperative encirclement hunting guidance method is proposed, which improves the cooperative interception ability of maneuvering targets and the cooperative attack ability of stationary targets. The relevant theoretical algorithms are verified in a variety of UAV swarms. As the first/corresponding author, he has published more than 20 high-level papers, including more than 10 SCI papers such as IEEE TCYB, IEEE TNNLS and CEP, and more than 10 EI papers, and has obtained 3 authorized national invention patents. He served as reviewers of IEEE Transaction on Cybernetics, ISA Transaction, as well as international and domestic journals such as Acta Aeronautica Sinica and Modern Defense Technology. He is a member of the three committee members of CICC. He presided over the fund of the National Natural Science Foundation of China and China Postdoctoral Science Foundation. He has won the first prize of science and technology progress award of CICC, excellent doctoral thesis of CICC, and best student paper award of 2021 CCSICC.

Details of Session

With the advancement of perception, planning, and control in algorithms and hardware, aerial swarms have developed rapidly in recent years. In the near future, our airspace may be shared by a large number of aerial robots, performing complex

tasks that a single ground robot cannot accomplish. However, to achieve fully autonomous, reliable, and safe aerial swarms, many technological gaps in the current field still need to be bridged. Restricted by weight, size, and power, aerial robots usually have very limited perception and computing capabilities. Furthermore, complex tasks and environmental constraints often bring swarms requirements for high-precision perception, planning, control, and decision-making. The above problems arise the topics of this special issue: 1. How to design efficient distributed control and planning algorithms to achieve autonomous coordination of aerial swarms in complex environments. 2. How to propose a flexible swarm architecture to support robust operation of large-scale swarm systems under the constraints of communication range and bandwidth. 3. How to fuse heterogeneous sensors to exploit multi-source information and improve the sensing range and accuracy of swarm systems. 4. How to propose new types of hardware and system schemes to expand the boundaries of the existing platform's passability and versatility, and more related topics.

The invited session invites original papers of innovative ideas and concepts, new discoveries and improvements, and novel applications relevant to the following selected topics of “Navigation and Control of Swarm of Aerial Robots”.

- Aerial swarm robotics: modelling, design, and control
- Motion planning and control in distributed systems
- State estimation in distributed systems
- New concepts of hardware designs for aerial swarms
- Real-time optimization, planning, and decision making for aerial swarms
- Human-swarm interaction
- Multi-agent systems and algorithm validations