

Research topics for graduate students for 2024

Assistant Professor Moju Zhao

Department of Mechanical Engineering

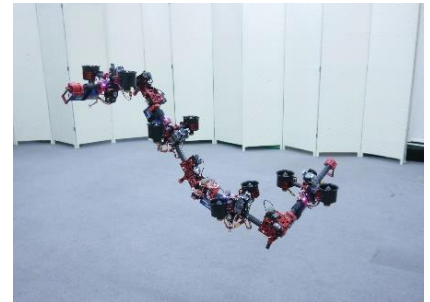
Acceptable course(s)

- Master's Degree
- Doctoral Degree



Research Topics

The main topic of research is the intelligent robotics from the aspects of mechanical design, motion control and planning, computer vision, and artificial intelligence. The most original achievement in this research is the articulated aerial robots called DRAGON [1], as shown in right figure.

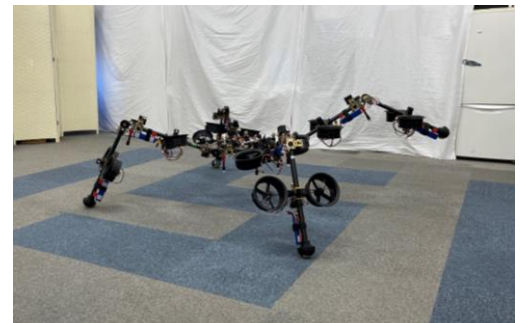


1. Aerial Maneuvering and Manipulation by Articulated Aerial Robot

The unique skill of the articulated aerial robot is the ability to perform snake-like maneuvering and arm manipulation using the articulated structure [2]. The main challenges to achieve this ability is the flight control and motion planning based on the methodology of multi-rigid-body kinematics and dynamics.

2. Quadruped Robot with Multi-modal Locomotion Capability

We develop a novel quadruped robot called SPIDAR [3] that can both walk and fly, as shown in the right figure. This robot not only has the multimodal locomotion capability, but also contains the potential of the manipulation in both terrestrial and aerial domains. Ongoing studies about this robot involve advanced mechanical design, hybrid control, and original motion planning using multiple end-effector.



3. Robotics Application in Plant Digital Transformation

Digital Transformation (DX) for plants is a cutting-edge topic in the robotics field. Many of the high-place works (e.g., pipeline inspection) can be replaced by drones. However, general drones can only serve as eyes for inspection. Thus, we introduce our articulated aerial robot for extended applications, such as valve operation [4]. We also focus on the collaboration between aerial robots and ground robots for large-scale inspection and maintenance.

Articles Related to Research Topics

- [1] M. Zhao, et al, Design, Modeling, and Control of an Aerial Robot DRAGON: A Dual-Rotor-Embedded Multilink Robot With the Ability of Multi-Degree-of-Freedom Aerial Transformation, IEEE RA-Letters, vol. 3, no. 2, (2018), [DOI: 10.1109/LRA.2018.2793344].
- [2] M. Zhao, et al., Versatile articulated aerial robot DRAGON: Aerial manipulation and grasping by vectorable thrust control, International Journal of Robotics Research, (2022), [DOI: 10.1177/02783649221112446].
- [3] M. Zhao, et al, Design, Modeling and Control of a Quadruped Robot SPIDAR: Spherically Vectorable and Distributed Rotors Assisted Air-Ground Amphibious Quadruped Robot. arXiv , (2023).
- [4] M. Zhao, et al, Forceful Valve Manipulation With Arbitrary Direction by Articulated Aerial Robot Equipped With Thrust Vectoring Apparatus, IEEE RA-Letters, vol. 7, no. 2, (2022), doi: 10.1109/LRA.2022.3154018.