Beyond Horizon: A One-Shot Space Exploration Paradigm Through Autonomous Space Systems

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12:30 PM

Maeder Hall Auditorium

MAE Special Seminar Series

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Historically, exploring a new planet or moon involves a multi-phase approach. First, an orbiter is used for surveying the target body to collect prior information, and then a lander/rover is used for more detailed terrain and subterranean science data collection. Although this has been a successful strategy and improves the safety of missions for near-earth bodies, it is not a practical approach for exploring fast-moving objects like long-period comets, subsurface oceans on icy moons, and lunar caves. The challenge arises from extensive mission development and deployment times and the limitations of orbiters in providing comprehensive information about such extreme environments. In this talk, I will present how aerospace autonomous systems could revolutionize exploration through a novel 'one-shot' paradigm, requiring minimal prior knowledge about the terrain and the environment. I will illustrate this through the following examples:

- CADRE (Cooperative Autonomous Distributed Robotic Exploration): Lunar Terrain Collaborative Formation Sensing
- On-Orbit Inspection Using Information-Based Guidance and Control
- Strategy for Learning the Interaction with the Environment Using Planning Under Uncertainty

Additionally, I will discuss recent updates on a multi-modal mobility platform, the EELS (Exobiology Extant Life Surveyor) robot, to access extreme environments. This discussion will highlight the importance of an integrated approach, combining architectural innovation, fundamental algorithm development, and the design of new mobility platforms to navigate extreme environments and venture into territories previously unreachable by robots.

Dr. Yashwanth Kumar Nakka is currently a Robotics Technologist at NASA Jet Propulsion Laboratory, where he leads the research and development planning, controls and estimation tasks on CADRE, EELS, and DARPA LINC . His research interests broadly include design of aerospace autonomous systems, spacecraft autonomy, planning (guidance) under uncertainty, and nonlinear dynamics and control. He received a B. Tech. in aerospace engineering from the Indian Institute of Space Science and Technology, India, in 2011, an M. Sc. degree in aerospace engineering from the University of Illinois Urbana-Champaign, IL, USA, in 2016, and an M. Sc. degree and a Ph.D. in space engineering from California Institute of Technology, CA, USA, in 2017, and 2021, respectively. He was an engineer for the GSAT-15 and 16 missions at the Indian Space Research Organization from 2011 to 2014. He received the best student paper award at the 2021 American Institute of Aeronautics and Astronautics Guidance, Navigation, and Controls conference and the best paper award at the 11th International Workshop on Satellite Constellations and Formation Flying. In addition, he serves as AE for AIAA Scitech 2023 for Autonomy and AI track for Aerospace Vehicle GNC and is an AIAA GNC Technical Committee member.

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