ME Seminar

Toward Resilient Multi-Robot Autonomy in Unstructured and Extreme Environments

Dr. Vivek Shankar Varadharajan, Co-Founder and CTO of Uncharted AI

ABSTRACT

Autonomous navigation and exploration in unstructured environments—such as underground mines, collapsed tunnels, and remote natural terrains—present formidable challenges for robotic systems. These settings are often GPS-denied, communication-limited, and physically complex, requiring resilient, decentralized, and intelligent robotic behavior. In this talk, I will present our recent progress at Uncharted AI in developing a robust multi-robot autonomy framework tailored for mining and space applications. The architecture integrates real-time SLAM-based map merging, hierarchical planning layers (mission, global, and local), and decentralized communication strategies. Robots explore unknown terrains autonomously, build a shared representation of the environment, identify scientifically or industrially valuable sampling sites, and maintain ad-hoc communication networks. I will share key insights from field deployments conducted in Mars-analog and mining-relevant environments, demonstrating how the system supports both scientific exploration and operational resource assessment. The talk will conclude with open research challenges and opportunities for collaboration to advance resilient multi-robot autonomy in harsh real-world settings.

ABOUT THE SPEAKER

Dr. Vivek Shankar Varadharajan is the Co-Founder and CTO of Uncharted AI, a robotics startup tackling some of the most challenging problems in the mining sector through autonomous robotic systems. He is also a postdoctoral researcher in the Computer Engineering Department at Polytechnique Montréal. His research focuses on multi-robot systems, distributed autonomy, and robust navigation in GPS-denied and communication-constrained environments. Dr. Varadharajan has led the development of scalable autonomy frameworks for both terrestrial and space applications. He was part of NASA JPL's CoSTAR team in the DARPA Subterranean Challenge and has spearheaded large-scale field deployments in extreme conditions. At Uncharted AI, he leads efforts to translate cutting-edge research into deployable technologies for mining, environmental monitoring, and geophysical resource assessment. His current work centers on integrating SLAM, risk-aware planning, and multi-sensor fusion to enable autonomous exploration and in-situ geochemical sampling. He actively collaborates with both academia and industry, driving innovation in resilient multi-robot systems for real-world impact.

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