Autonomous Vision-driven Robotic Manipulation in Space: On-orbit Assembly with a CubeSate Arm, Sample Tube Pickup for Mars Sample Return

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Abstract

I will discuss the experimental validation of autonomous robot manipulation behaviors that support on-orbit assembly, and the exploration of Mars' surface, lava tubes on Mars and the Moon, icy bodies and ocean worlds. I will frame the presentation with the following questions: What new insights or limitations arise when applying algorithms to real-world data as opposed to benchmark datasets or simulations? How can we address the limitations of real-world environments— e.g., noisy or sparse data, non-i.i.d. sampling, etc.? What challenges exist at the frontiers of robotic exploration of unstructured and extreme environments? I will discuss our approach to validating autonomous machine-vision capabilities for the notional Mars Sample Return campaign, for autonomously navigating lava tubes, and for autonomously assembling modular structures on orbit. The talk will highlight the thought process that drove the decomposition of a validation need into a collection of tests conducted on off-the-shelf datasets, custom/application-specific datasets, and simulated or physical robot hardware, where each test addressed a different range of experimental parameters for sensing/actuation fidelity, breadth of environmental conditions, and breadth of jointly-tested robot functions.