AstroSLAM - A Robust and Reliable Visual Localization and Pose Estimation Architecture for Space Robots in Orbit

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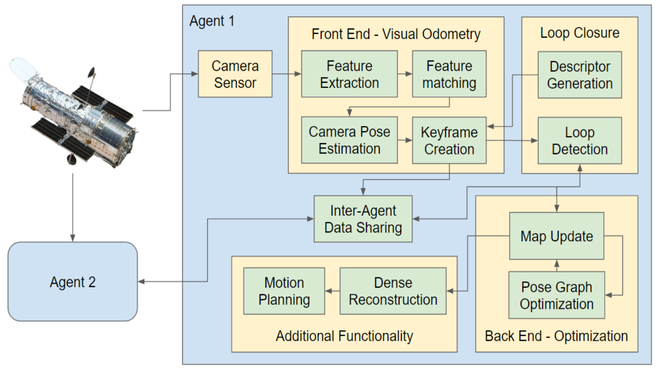
https://dcsl.gatech.edu/research/space-robotics-astroslam.html

Project Objectives and Goals

- Develop the next-generation **multi-agent sensing, planning and scene reconstruction techniques** for resilient autonomous on-orbit servicing operations

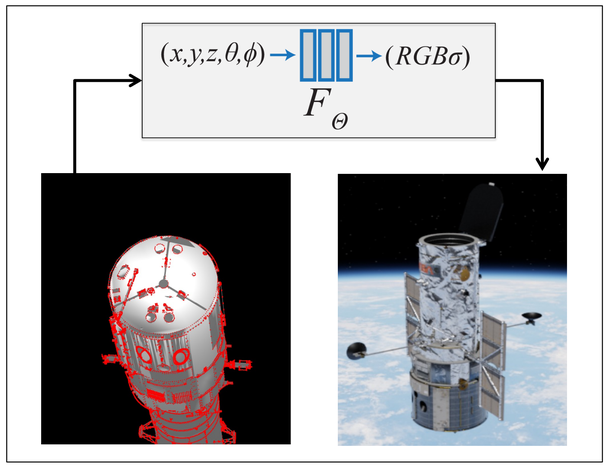
Main Challenges

- Collaborative sensing architecture robust to harsh space environmental conditions (challenging lighting, communication bandwidth)
- Task-specific motion planning accounting for orbital mechanics, limited fuel, collision avoidance
- Real-time accurate 3D scene reconstruction



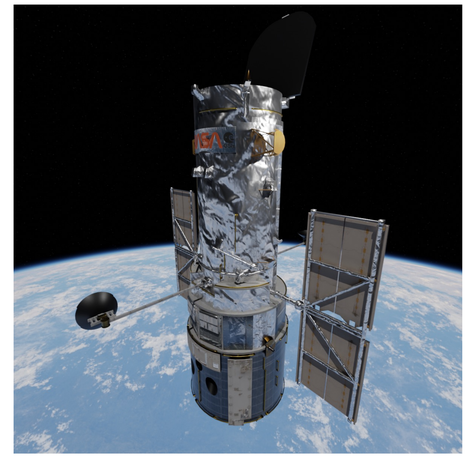
Technical Approach

- Reliable features tracking through extraction of geometric primitives and keyframe selection
- Agent constellation sharing key data through robust distributed pose graph
- Informative and efficient motion planning through factor graphs optimization
- Learning-based real-time scene reconstruction through specialized neural radiance fields

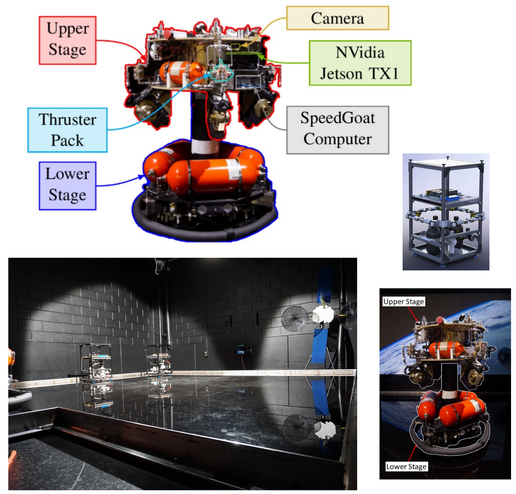


Scientific Impact

- Enhanced visual front-end apt to perform feature detection and tracking in extreme scenarios
- Lightweight multi-agent collaborative sensing architecture easily scalable to a variety of resource-critical applications
- Advancements in multi-objective / multi-agent motion planning at a conceptual, technical and implementation level
- Real-time multi-view perception and shape reconstruction in challenging operational conditions



Experimental Validation



Broader Impacts

- Enable autonomous operations in remote and inaccessible environments (e.g., search and rescue, underwater inspection)
- Safe decommission, maintenance and upgrade of the current space infrastructure
- Robotics-enabled media coverage of in-space operations attracting diverse and young audience

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