GSI GEISEL SOFTWARE
SWARMING SPACE ROBOTICS TECHNOLOGICAL INNOVATION

INNOVATING SPACE EXPLORATION

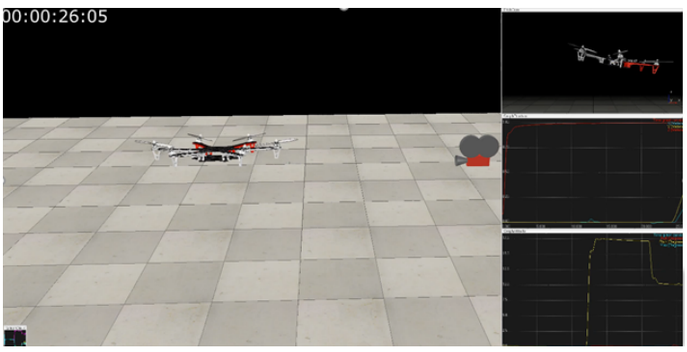
Robots will blaze new trails on distant and hostile worlds to better our understanding of the universe and to extend the reach of the human race. Geisel Software (GSI) is currently working on several swarming robotics initiatives for NASA designed to help create robots that can be leveraged as precursor explorers preceding crewed missions, as crew helpers, as extravehicular activity (EVA) mobility aids, and as caretakers of assets left behind.

Robotic Simulation for Sourcing and Mapping

GSI is building a realistic, high-quality robotic simulator platform with embedded atmospheric conditions that will allow us to develop and test collaborative mobility and manipulation in a heterogeneous robotic environment. This includes the ability for robots to handle problem-solving on their own, as well as both high-level and direct control from humans when desired.

The software platform will:

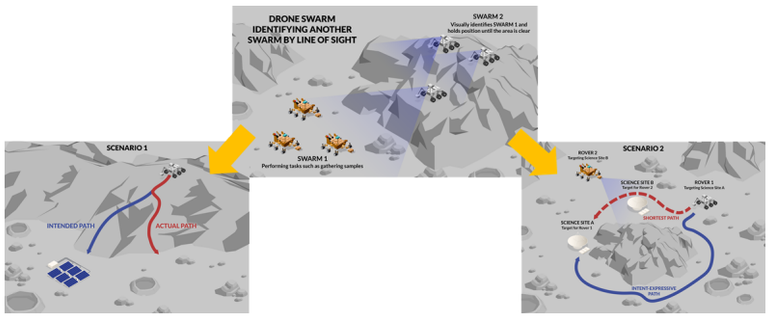
- Simulate UAVs navigating under different atmospheric conditions with radiation, particulate matter or dust, and other compounds.
- Simulate motion planning of UAV and UGV, optionally with satellites, for enhanced measurement capabilities including source search and mapping tasks and enabling many other future tasks as well.
- Embody scientific and engineering challenges related to both sensor development and its dynamic network design.
- Provide the ability to facilitate multi-agent coordination across entire planetary bodies, with less than ideal networking conditions and with optional human interaction when desirable.



V-Rep Based Control Simulation for a fully-actuated Hexrotor

Communicationless Coordination for Intent Perception

GSI is also developing and exploring technologies that enable cooperative operation of low-cardinality swarms of space vehicles in an unknown dynamic environment. We are developing algorithms for communicationless coordination that will observe and estimate the actions and intentions of other agents in a multiagent system in lunar and planetary exploration missions.



The technical objectives of this project include:

- Developing set-based and probabilistic behavior and intent estimation/prediction algorithms to infer the set of possible models/behaviors/intents that are compatible with noisy observations and their associated likelihoods.
- Designing (optimal) intent-expressive/legible motion planning algorithms to render the intent estimation algorithms more effective in cooperative settings with the goal of increasing overall social/team performance.
- Building a realistic simulation platform to mimic rover driving on moon and planetary terrains with uncertain terrain parameters.
- Integrating and testing the intent estimation and intent-expressive motion planning algorithms within the simulation platform.

Technologies/Concepts We're Exploring

Simulation with embedded atmospheric conditions
Gazebo
ROS
Monte Carlo N-Particle Transport (MCNP)
Radiation 2D contour mapping and source localization
3D robot swarm algorithm for search and mapping
Multigroup swarm implementation
Computer vision
Machine learning
Swarm Intent estimation/perception algorithms
Intent expressive/motion-planning algorithms
Bayesian learning and target tracking
Set-based estimation/model (in)validation algorithms
Active model discrimination (open-loop)
Active feedback model discrimination
Realistic simulation environment
Algorithm/simluation integration
Human/robot interaction

For more examples of Geisel Software's capabilties, please visit geisel.software/portfolio.