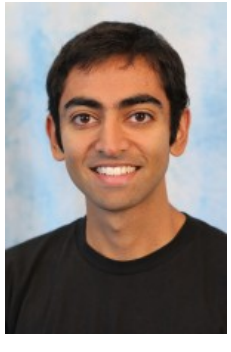
The Field Robotics Center

Seminar Series

Monday, 18th April

GHC 2109 1:30 – 2:30pm

Lunch will be served



Neal Bhasin

M.S. Student

Robotics Institute

Fuel-Optimal Spacecraft Guidance for Landing in Planetary Pits

Abstract: Propulsive spacecraft enable scientific discovery and exploration of the worlds beyond Earth. Autonomous spacecraft have landed on Earth, the Moon, Mars, Mercury, Venus, Titan, asteroids, and a comet. Recently discovered planetary pits allow access to subsurface voids valuable for scientific discovery and sustained exploration. With recent advancements in embedded convex optimization software and trajectory optimization theory, increasingly sophisticated autonomous missions will be able to safely and efficiently reach these unexplored destinations.

This research develops and tests an algorithm for fuel-optimal landing into planetary pits. By representing the safe regions outside and inside a planetary pit as distinct convex spaces, techniques for optimal guidance based on convex optimization are extended to find trajectories into pits. A search routine for time of flight and time of entry into the pit finds globally fuel-optimal landing trajectories. This time search softens constraints on maximum thrust and landed vehicle mass to reliably find solutions without sensitivity to initialization. The algorithm is implemented within a modeling language and uses an embedded solver for convex optimization. The resulting implementation is therefore practical and effective for use in future missions.

The algorithm is tested in landing scenarios that vary vehicle parameters, mission constraints, and pit dimensions. The feasibility and optimality of generated trajectory solutions are examined along with algorithm runtime. This research determines that fuel-optimal guidance capable of landing within planetary pits is viable for future missions.

Speaker Bio: Neal Bhasin is a M.S. student in the Robotics Institute advised by Prof. Red Whittaker. Neal received his bachelor's degree in Computer Science from Carnegie Mellon in 2015 and has done research in the Planetary Robotics Lab since 2012. He served as team leader on the NASA funded instrument project "Flyover Mapping and Modeling of Terrain Features", which culminated in a successful flight demonstration of high resolution 3D terrain modeling using camera and LIDAR data collected onboard a reusable launch vehicle.

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