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SIMULATION OF PRECISE AND SAFE LANDING NEAR A PLUME SOURCE IN A TIGER STRIPE CANYON ON THE SOUTH POLE OF ENCELADUS

Abstract

This paper presents a simulation tool for planetary landing operations near a plume source on the bottom of a tiger stripe canyon on the South Polar Terrain of Saturn's moon Enceladus, reports on its development status, and presents results from the landing simulation.

Enceladus is a promising hot spot for astrobiology in the solar system. A concept studied at the Institute for Space Technology and Space Applications (ISTA) of Bundeswehr University Munich in the context of the DLR funded Enceladus Explorer project (EnEx) aimed to place a lander near one of the plume sources on the bottom of a "tiger stripe" canyon on the south pole of Saturn's moon Enceladus. A spacecraft landing near one of the plume sources and deploying a melting probe to sample relatively shallow liquid water in the ice under that plume source would be able to look for signatures of life before they are degraded by exposure to the vacuum of space.

The lander would have to meet very challenging landing accuracy and reliability requirements on an exceptionally challenging terrain. To perform this challenging landing, a sophisticated landing Guidance, Navigation, and Control (GN&C) system would be necessary. For the lander to land within the narrow canyon floor with the required accuracy, a terrain relative navigation (TRN) function can use sensors such as optical and thermal cameras, LIDAR, etc. to navigate relative to detected terrain features. To ensure a safe landing in the hazardous terrain, a hazard detection and avoidance (HDA) function must be able to assess if the originally planned landing site is safe, and if not to then autonomously command a retargeting to another safer spot. The guidance and control (G&C) function must then calculate a viable trajectory and thrust arc to the newly chosen landing site.

To validate that the landing satisfies the accuracy and reliability requirements we are developing a tool in Matlab to simulate the operation of the autonomous landing GN&C system. In this paper we describe the tool and we present its development status. We then demonstrate that the accuracy and safety requirements are met for landing on an adequately realistic "tiger stripe" canyon-like simulated terrain. Based on the simulation results we also propose possible modifications to the landing GN&C system.