SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

Author: Mr. Christopher Nicol
Faculty of Engineering, Carleton University, Canada, christophernicol@cmail.carleton.ca

Prof. Alex Ellery
Carleton University, Canada, aellery@mae.carleton.ca
Prof. Edward Cloutis
The University of Winnipeg, Canada, e.cloutis@uwinnipeg.ca

TARGETING ENCELADUS' PLUME - THE VIFFING PENETRATOR APPROACH

Abstract

The Saturnian moon Enceladus exhibits water geysers which issue from large fractures in the South Polar Region named 'tiger stripes'. Based largely on data collected from the Cassini spacecraft since 2005, several theories about the origin of the geysers exist, as well as the thermal anomaly which seems to be associated with the geyser locations. A subsurface ocean of liquid water is thought to exist beneath these features, and could be one of the more habitable environments in the outer solar system. To determine the state of the aqueous environment beneath the tiger stripes, we propose a penetrator mission whose goal is to impact the site where plume ejection occurs. One of the core difficulties in this undertaking is locating, and maneuvering to, the jet locations in the Tiger Stripes. The ability to vector in forward flight (VIFF), i.e., provide lateral velocities during the "free fall" phases of the mission, will allow the penetrator to course-correct in real time up to the point of impact. This provides a significant advantage over the traditional penetrator, which has no means of control once it is ejected from the carrier and begins "free fall". Ejected particles diffuse into the plume as the various jets interact. However, both the density of particles and mean particle size are greater along the projection path leading from the jet. A navigation system is created to localize these jet locations by sampling the plume density and particle size during decent. This system is based on the Kalman Filter and uses a Gaussian model of each jet to estimate the rate of diffusion into the plume. A control system is used to actively reorient the penetrator to impact the target site, while realizing the impact conditions necessary for survival, proper orientation of both the penetrator and the velocity vector. The advantage of a penetrator mission is the low mass associated with the decent vehicle. We review the required forces for mission success given by simulations of the control system, and discuss the ability of providing these forces with actuators that fit the constraints.