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TARGETING ENCELADUS' GEYSER VENTS USING PENETRATORS EMPLOYING BIOMIMETIC PLUME SNIFFING

Abstract

The icy moons of the solar system represent the most promising targets for astrobiological exploration. Direct access to the geyser vents of Enceladus would be highly desirable to acquire pristine biological samples but considered very challenging. The landing target coordinates are priori unknown and must be inferred by the landing vehicle itself during descent. We present an approach that offers the prospect of targeting the sources of Enceladus' icy plumes using one or more penetrators. Penetrators are small missile-type entry descent and landing vehicles that can carry modest scientific instruments capable of withstanding impact into the subsurface. By continuously measuring the water concentration of the icy plume, the penetrators can locate the plume source and target it for impact. The penetrators' trajectory and plume source localization are been addressed. Calculations of the sphere of influence, freefall time and penetrator impact velocity are input parameters from which we design three types of descent profiles. The descent profile involves vectoring-in-forward-flight (viffing) – it may be ballistic (with minimal Δv cost), spiraling (with highest Δv cost) or a hybrid approach of nested boxes (with intermediate Δv cost) for which we present trajectory maneuver simulations. The simulations illustrate that the hybrid approach is favored and is tailorable with modest Δv costs traded with targeting accuracy. We determine that the proposed vectoring-in-forward flight (viffing) maneuvers is feasible and permits accurate targeting of Enceladus' subsurface vents.