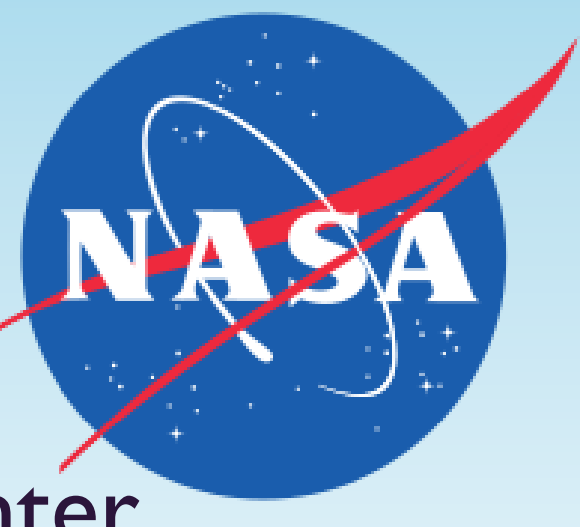


Aerial Vehicles to Detect Maximum Volume of Plume Material Associated with Habitable Areas in Extreme Environments

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BACKGROUND

Current technologies of exploring habitable areas of icy moons are limited to flybys of space probes. This research project addresses long-term navigation of icy moons by developing a MATLAB adjustable trajectory based on the volume of plume material observed. Plumes expose materials from the sub-surface without accessing the subsurface. Aerial vehicles capable of scouting vapor plumes and detecting maximum plume material volumes, which are considered potentially habitable in inhospitable environments, would enable future deep-space missions to search for extraterrestrial organisms on the surface of icy moons.

OBJECTIVES

- To implement touring simulated plumes and plan volume maximizing trajectories in MATLAB
- To demonstrate the potential of using volume maximizing trajectories as a means of autonomously navigating an aerial vehicle can have in improving the capabilities of long-term space navigation and enabling technology for detecting life in extreme environments

IMPLEMENTATION

MATLAB Simulation

- Developed an adjustable trajectory path-planner dependent on the maximum volume of plume material observed to represent the trajectory of an aerial vehicle system, herein called 'Smart Explorer'
- Validated trajectory metrics compared with a Spiral trajectory, herein called 'Spiral Explorer'

SIMULATION

SIMULATION VIDEO on IPAD
(iPad + frame fits here)

RESULTS

The 3D Maximum Volume Trajectory followed a maximum gradient path in a 252x252x252 randomly generated, simulated plume data matrix. The 2D Trajectories were tested using the 252x252 matrix taken from the middle level of the generated plume used to get data for the 3D Maximum Volume Trajectory. The volume explored includes duplicate volumes explored to include the possibility of returning to the previous position if there is more volume material located there (likewise for area explored).

	3D Smart Explorer	2D Smart Explorer	2D Spiral Explorer
Sum Collected Data per Path	4.01	1.70	805
Volume or Area Explored per Path	238 units ³	116 units ²	64002 units ²
Time per Path	0.00315 seconds	0.0011 seconds	0.0011 seconds
Total Paths Explored	50	20	1

DISCUSSION

Two types of explorer algorithms were implemented in MATLAB and their metrics were compared. The controlled trajectory was the '2D Spiral Explorer' and the experimental trajectory was the '2D Smart Explorer.' The Spiral Explorer travelled the environment in a rectangular spiral while the Smart Explorer travelled by the route of steepest ascend in terms of plume density. Since the Smart Explorer follows the maximum density gradient, it was hypothesized that the Smart Explorer would collect the maximum amount of data in the shortest time period. However, the results of this project were counter-intuitive as reflected in the Results Section. This was due to several unforeseen reasons including: processing time, random starting position of the Smart Explorer, and the 'short-sight' of the Smart Explorer when calculating the next move. The results of this project leaves numerous important extensions open for future research.

FUTURE APPLICATIONS

Aerial vehicles that are sent to map extreme environments of icy moons or the planet Mars, could carry small payloads with automated cell-biology experiments, designed to probe the biological response of low-gravity and high-radiation planetary environments, serving as a "pathfinder" for future human missions.

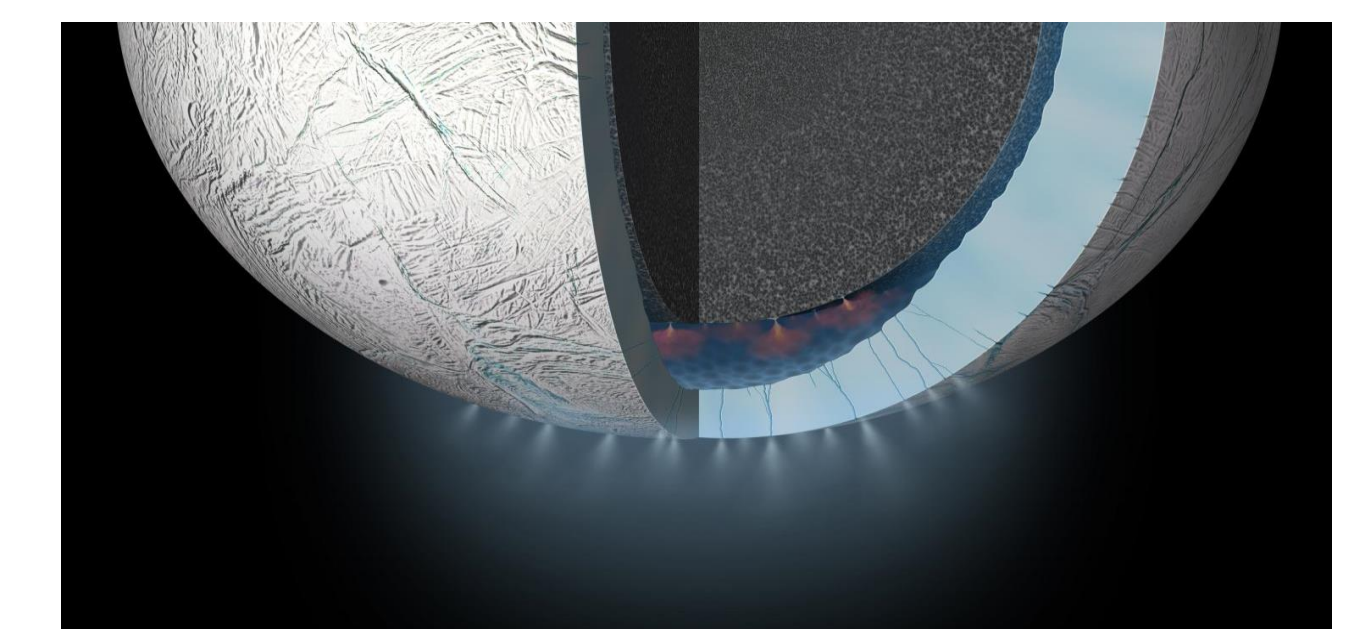


Image: NASA Credit: NASA/JPL-Caltech

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