EXPLORING TITAN USING VIRTUAL REALITY WITH DATA FROM THE *DRAGONFLY* MISSION.

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Introduction: The Johns Hopkins Applied Physics Laboratory (APL) is proposing the *Dragonfly* mission that will explore Saturn's moon Titan in order to investigate its prebiotic organic chemistry [1]. A rotorcraft designed to fly in Titan's dense atmosphere and low gravity will carry cameras and lidar that can be used to create three-dimensional representations of Titan's terrain. We describe a Virtual Reality (VR) environment that allows a 3-D immersive experience of the Titan data.

Current Capabilities: The current implementation of the tool simulates Titan with terrestrial data and imagery similar to what will be taken during the actual mission. A digital elevation map with 1-m resolution is overlaid with aerial imagery to create a Titan-looking landscape. The VR environment incorporates a 3-D model of the rotorcraft which can be flown around the scene or scripted to follow predesigned flight paths. Multiple viewing perspectives are available, including *Dragonfly* camera fields of view as well as third-person views from outside the rotorcraft. The environment can also execute scripted sequences illustrating *Dragonfly* operational scenarios. During science operations, the VR environment will be used by engineers and scientists to visualize the lander in the Titan environment and inform decisions such as selecting sampling locations.

Data Input: Planned data input for the tool during operations will consist of imagery from onboard cameras, point cloud data from the onboard lidar, reconstructed digital terrain maps, and both planned and reconstructed rotorcraft position and orientation. Both planned and as-flown sequences will also be available for playback, allowing scientists and engineers to visualize the sequences and review them for science utility and safety. Data derived from science pipelines and archives, as well as tools like the Small Body Mapping Tool [2] provide a rich source of input for such a visualization tool.

Benefits to the Community: The main benefit of the VR approach is to present an accurate scientific depiction of the inherently 3-D data being returned by the mission. Other features may eventually be included to assist with science analysis and what-if scenario planning. Of particular interest will be the ability to facilitate remote collaboration of multiple participants within the same VR environment.

While the tools as presented here focus on Titan and *Dragonfly*, they can be generalized to other planets and bodies where large datasets are present. The ability to overlay various data types (imagery, spectra, lidar, etc.) in one region gives the user the ability to not only see the data as a whole but also provides the user with the in-person, 3-D perspective that provides viewing angle and perspectives that are not possible when looking at a 2-D display of the data.

Demonstration: We will provide an active demonstration of the existing capability and will present some scripted views of *Dragonfly* scenarios.

References: [1] http://dragonfly.jhuapl.edu/ [2] Ernst et al. (2018) *The Small Body Mapping Tool (SBMT) for Accessing, Visualizing, and Analyzing Spacecraft Data in Three Dimensions*, LPSC 49, abstract no. 1043