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TOWARDS A 3D-GIS FOR HERA

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Extended Abstract

The Hera Mission [Michel et al., 2022] will rendezvous with the binary asteroid system Didymos in 2027, to perform a detailed post-impact survey of the orbiting Moonlet Dimorphos, after NASA's DART impact on 2022-09-26 [Rivkin et al., 2021]. Hera carries remote sensing instruments to characterize primarily Dimorphos' surface during its half-year approach, observation and experimental phases. Imaging in the visible and infrared range is complemented by hyperspectral images, a laser altimeter, radio science, and CubeSats.

Laser altimetry and imaging in various phases will enable the assembly of 3D models in gradually improving levels of detail to support analyses of global properties, shape, volume, geomorphology, optical and thermal properties, space weathering, composition, debris and dust distribution, as well as a particular focus on the DART impact crater and its properties in highest available resolution.

The Hera Science Team will produce medium-level products and layers such as albedo map, thermal inertia map, colour and hyperspectral texture, the instruments' footprints, observation conditions (shadows, sun exposition, incident angles), and (spatially distributed) knowledge about observation uncertainty.

The target science cases requiring the 3D context and embedding of multiple cues include composition (from albedo + spectra + shape), evolution (from maps of morphological features + shape + roughness), and the effects of the DART impact (ejecta distribution, surface changes).

The **spatio-temporal maintenance** of the medium-level data products (including links to their raw data origins) on top of the asteroids' models – which are emerging as Hera approaches – is **key for a holistic understanding of the science return**.

The **definition and localization of targets and regions of interest** on (different versions of) the shape models, the ability to annotate and analyze the geomorphologic properties in a quantitative way (measure distances, angles, areas, volumes and derived statistics), and the ability to maintain different versions of the named entities are further requirements that led to the decision to provide a 3D Geographic Information System (3D-GIS), being able to represent the necessary functionalities.

PRo3D (The Planetary Robotics 3D Viewer, [PRo3D, 2022]) is the ideal tool for Hera 3D-GIS extensions – it already has some preliminary GIS functionality. It shall ingest **geometry and texture layers** describing medium-level products and cues.

PRo3D allows **interactive 3D geometry and texture display** (see Figure 1), **manipulation and arbitrary combinations** thereof, enables **annotations and quantitative 3D analysis** and, by means of an underlying data base, supports the **reference between observations and to raw data products** and their observation conditions [Paar et al, 2023].

A **target and Region-of-Interest maintenance** capability is within the set of requested functions, similarly the analysis of 3D surface changes.

PRo3D 3D-GIS capability is currently under development, using simulated data, tailored to the Hera use case.

Further design discussions are primarily involving the Hera Working Group 4 ("Data Analysis, Exploitation, Interpretation").

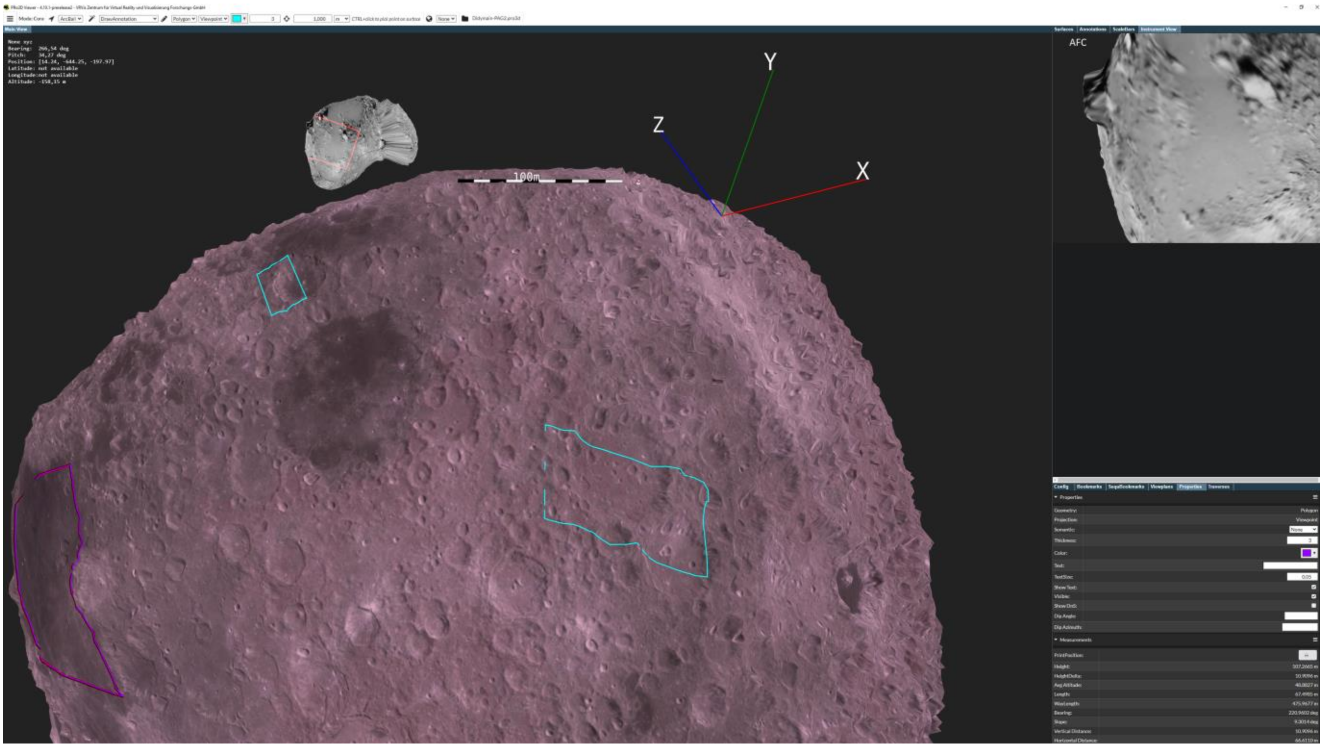

Figure 1: PRo3D, displaying simulated binary asteroid system (left) and instrument view (top right and its footprint annotated in red in the main view), as well as simple annotations such as a coordinate system, polygons circumventing Regions of Interest, and a scale bar.

References:
[Michel et al., 2022] https://iopscience.iop.org/article/10.3847/PSJ/ac6f52/meta
[Rivkin et al., 2022] https://iopscience.iop.org/article/10.3847/PSJ/ac063e/meta
[PRo3D, 2022] https://github.com/pro3d-space/PRo3D
[Paar at al., 2023] https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022EA002532