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DEVELOPING AUTONOMOUS IMAGE CAPTURING SYSTEMS FOR MAXIMUM SCIENCE YIELD FOR HIGH FLY-BY VELOCITY SMALL SOLAR SYSTEM BODY EXPLORATION

Abstract

In this paper, we will present the ongoing work to develop autonomous image capturing strategies for Optical Periscopic Imager for Comets (OPIC), an instrument onboard the Comet Interceptor ESA F-class mission (in cooperation with JAXA) to be launched in 2028. The mission will perform multi-point measurements using three probes that will intercept either a long-period comet, a dynamically new comet, or an interstellar object.

OPIC is a periscopic monochrome camera on a spin-stabilized sub-spacecraft of the mission. The tasks of this instrument is to take images of both the nucleus and coma both for mapping and reconstruction, and spatial localization purposes. Since the baseline relative interception velocities can be up to 70 km/s, the fly-by of the target, during which the comet nucleus is visible, can last only for a few hundred seconds. The phase, during which the coma can be imaged, will be longer, but the task will still be challenging due to the mission configuration and limited resources on the sub-spacecraft, mainly arising from the highly limited data budget for OPIC (around 10 kb/s) and the fact that the spacecraft can be damaged to the point of disrupting any further image acquisition and data transfer at any moment due to potential high-velocity particle impacts.

Our approach is to use photorealistic 3D rendering, specifically using Blender and Cycles rendering engine, to produce a representative set of potential fly-by images based on expected possible encounter geometries and targets. Then, the datasets will be used in our reconstruction and data extraction pipelines in order to select the subsets that will provide the most scientific value within the possible transmission data budget. The final step is then to implement the strategies in the software and firmware controlling OPIC to perform the image capturing and sub-selection steps autonomously.

This approach can be also applied to other fly-by missions, such as the Multi-Asteroid Touring (MAT) mission concept we have been developing with partners, mainly centered around Finnish Meteorological Institute, allowing to access a far larger set of small solar system bodies than feasible with current mission architectures.