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OPIC ON COMET INTERCEPTOR: TOWARDS AUTONOMOUS IMAGING OF POORLY CHARACTERIZED TARGETS OF OPPORTUNITY

Abstract

OPIC (Optical Periscopic Imager for Comets) is an instrument on ESA F-class mission Comet Interceptor, which is the first ESA mission that is launched before its target object has been identified. This mission concepts allows to study objects that are entering the inner Solar system for the first time or visiting the inner area for a short time, such as dynamically new comets or interstellar objects. The mission is in the stage of flight model deliveries and is expected to launch either in 2028 or 2029.

Such targets represent a unique scientific opportunity but also introduce significant operational challenges that many conventional space missions do not have to deal with. The target will be poorly characterized prior to the encounter and therefore key properties (including the target's optical properties, size, and activity) will be unknown. Co-orbiting and extended observation campaigns are impossible, so the mission will rely on a single high-speed flyby. Due to the many unknowns, there is a large threat of spacecraft loss.

To mitigate these issues, OPIC employs a fully autonomous imaging and data-handling strategy. The system is designed to automatically detect the target, identify the images containing the target, crop out the relevant image regions, and rapidly transmit them to Earth within a highly constrained data budget. All of this has to be done without operator intervention. This strategy allows to develop new types of missions and to characterize targets that are not feasible to characterize during more conventional missions. Effective scientific return is enabled even under highly uncertain circumstances.

This paper presents the concept, operational principles, development, testing and current state of the OPIC instrument, which is currently in the flight model assembly and testing phase and uses the IMPRIO IP core developed by Bitlake Technologies to autonomously identify the comet nucleus and extract regions of interest for prioritization.

We will also show our future developments towards making such systems much more capable, how to test them in simulations (such as our in-house FlyByGen, which was developed for ESA OSIP project "Leveraging high reliability low latency machine learning for imaging during very fast autonomous fly-by missions"), and how application of AI would help such systems to be even more capable in the future.