## IMAGE processing SW

VITO has ample experience with the data processing of imagery from radiometrically calibrated thermal cameras with an uncooled microbolometer (e.g. Workswell WIRIS 2 and similar cameras equipped with a FLIR 640 sensor with 17 µm pixel pitch, measuring in the 7.5 – 13.5 µm band). These camera’s are operated on Remotely Piloted Aircraft Systems (RPAS). During pre-processing, the collected data are validated using quality checks on the raw images and the flight and camera metadata (including onboard GPS data for georeferencing). Thermal images are processed through a structure from motion (SfM) photogrammetry workflow encompassing tie-point extraction and matching, outlier detection and bundle adjustment, optional measurement of additional manual tie-points and ground control points (GCPs), geometric camera calibration, colored dense point cloud generation, point cloud classification into terrain, above ground and noise points, raster digital surface model (DSM) and digital terrain model (DTM) generation, and true orthophoto projection onto the DTM. The resulting 16 bit thermal orthomosaic has pixel values expressed as digital numbers (DN) scaled to temperature (K). This can be done using open-source or commercial SfM photogrammetry software packages on Linux, for which VITO extensively tailored the processing workflow and parameters to handle the thermal data characteristics. Thermal imagery can also be used in a per-frame analysis workflow based on a live image feed using direct georeferencing. In the framework of the H2020 MONOCLE project, VITO developed a workflow running on a portable Linux computer (Raspberry Pi) carried by the RPAS to integrate a live multispectral VNIR image feed together with GNSS/IMU measurements from the RPAS platform and sensor gimbal, enabling real-time on-the-ground image analysis, stitching and camera feedback (e.g. adjusting image acquisition parameters). This system can easily be adjusted to handle a thermal imagery feed. It is our intention to modify the above technique to the conditions expected in the Hera mission concerning the different operations of the instrument and the expected images which are, unlike for the remote sensing on Earth, not covering the whole FOV of the camera.

The IMAGE processing system must be fully compliant with the navigation and scientific performance requirements. A software simulator to render scenes observed by the camera, which can then be used for the assessment of navigation (large distances and close encounters) and scientific performance will be developed. Realistic image simulation will use asteroid and spacecraft trajectory information, a camera model with appropriate radiometric scaling for the Didymoon environment, and 3-D shape models including the thermal properties and response over the asteroid surface. The trajectories will be extracted from the SPICE toolkit[[1]](#footnote-1), including camera positioning and orientation on the spacecraft. Rendering of the scene in 3-D can be done using open-source software, such as Cosmographia[[2]](#footnote-2) and Blender[[3]](#footnote-3). ROB has experience with both, and early on will weight their advantages to decide between them. The influence of thermo-physical properties will be determined by a 1-D thermal model applied across the asteroid surface, which gives the surface temperature resulting from equilibrium between insolation heat flux and radiative losses, taking into account time lag due to thermal inertia. The final simulation software will be able to produce images that consider various thermal inertia values, rock size and shape distributions, and HERA trajectories. Possibly we can use also earlier simulation results made in the TAIM study, if these can be provided by ESA. It is our intention (see next section) to obtain images with the thermal camera at a test site with “scaled asteroid” models under conditions similar as to expect near the asteroids to be used for the verification of the developed data processing algorithms.

The data processing will need to be performed on board of the Hera satellite before being downlinked to Earth. Different aspects of the data rate, necessary data storage will be included in this analysis.

1. https://www.cosmos.esa.int/web/spice/spice-for-hera [↑](#footnote-ref-1)
2. https://www.cosmos.esa.int/web/spice/cosmographia [↑](#footnote-ref-2)
3. https://www.blender.org [↑](#footnote-ref-3)