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Lutetia surface reconstruction and uncertainty analysis

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Multiple views of Lutetia taken from OSIRIS NAC payload can be used to perform a metric reconstruction of its shape. Reconstructed surface with its texture represents well the geomorphology of the body ad enable further scientific investigations.
The whole reconstruction process (from feature extraction to dense reconstruction) can be seen as an indirect measurement of the Lutetia surface. In this indirect measurement, the output quantity is a numerical evaluation of 3D surface of Lutetia, while the input quantities are the 2D positions of the detected features in each acquired image, and the intrinsic and extrinsic camera parameters that are used to describe the cameras (particularly NAC) of the OSIRIS payload.
In this work a general photogrammetric processing pipeline is described. Algorithms selected for feature extraction and matching, initial derivation of structure and camera relative motion, bundle adjustment and dense matching are presented and discussed.
The last step of the reconstruction process is the Bundle Adjustment which corrects simultaneously the bundle of rays in each image and the 3D points positions in order to reduce the image reprojection error. This error gives a metric to assess the performances of the whole reconstruction process and the quality of the produced surface. Moreover this step allows the assignment of the covariance of each input parameter and the estimation of outputs covariance.
A detailed uncertainty analysis is performed and several uncertainty sources are considered. Particularly, the uncertainty associated with the following quantities are analysed and evaluated: intrinsic and extrinsic parameters of the multi-view system, whose uncertainties are evaluated from SPICE kernels and Rosetta documents; the selected image feature detector and descriptor, which contribute to uncertainties associated with the used features positions in each image plane; the lighting of the scene, which causes a not negligible uncertainty contribution to 2D positions in the image plane.
The uncertainty evaluation in the indirect measurement is performed according to the standard metrological procedures. All the uncertainty sources are expressed by Probability Density Functions and are then propagated to the output surface of Lutetia.