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The use of 3D shape models of Rosetta targets for morphological studies

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Abstract

New 3D reconstruction techniques have been developed during the last decade to retrieve the global and/or local topography of small solar system bodies from visible images. These techniques can be separated into two categories: the so-called "photoclinometric" and the so-called "photogrammetric" techniques. Two implementations of the photoclinometric technique are available: the SPC technique (StereoPhotoClinometry) which combines sparse stereo with a classical clinometry algorithm[1] and a more recent method called MSPCD (Multi-Resolution Stereo-PhotoClinometry by Deformation) which proceeds by iterative deformation of a triangular mesh in a multi-resolution scheme[2], using stereo points as a guide during the deformation[3].
Our study is based on the 3D shape models of the asteroid Lutetia and of the comet 67P/Churyumov-Gerasimenko retrieved by the SPC and MSPCD methods. More specifically, we describe how the models produced by these two techniques can contribute to detailed and quantitative studies of the morphological properties of small bodies through three test cases shortly described below.
• Measurement of crater depth and depth-to-diameter distribution. We show that the reconstruction techniques can lead to systematic differences in the measurement of crater depth. This will be illustrated by a set of craters[4] identified in the Achaia region at the surface of the asteroid 21 Lutetia.
• Calculation of the volume of large boulders at the surface of comet 67P/C-G. We show how the reconstruction technique affects significantly the volume determination of a large boulder named Cheops in the Imhotep region.
• Measurement of gravitational slopes. We discuss the differences between the gravitational slope distributions in Seth obtained with the SPC and MSPCD models[5].
Since no ground control points are available on small bodies, we use the comparison of high-resolution images with the corresponding synthetic images generated with the models[6] to assess their ability to retrieve detailed topographic features at the surface of 67P/C-G and Lutetia.

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