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Detection of impact craters in 3D mesh by extraction of feature lines

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Abstract

Impact craters are observed at the surface of most solar system bodies: terrestrial planets, satellites and asteroids. The measurement of their size-frequency distribution (SFD) is the only method available to estimate the age of the observed geological units, assuming a rate and velocity distributions of impactors and a crater scaling law. The age of the geological units is fundamental to establish a chronology of events explaining the global evolution of the surface. In addition, the detailed characterization of the crater properties (depth-to-diameter ratio and radial profile) yields a better understanding of the geological processes which altered the observed surfaces. Crater detection is usually performed manually directly from the acquired images. However, this method can become prohibitive when dealing with small craters extracted from very large data sets.

A large number of solar system objects is being mapped at a very high spatial resolution by space probes since a few decades, emphasizing the need for new automatic methods of crater detection. Powerful computers are now available to produce and analyze huge 3D models of the surface in the form of 3D meshes containing tens to hundreds of billions of facets. This motivates the development of a new family of automatic crater detection algorithms (CDAs). The automatic CDAs developed so far were mainly based on morphological analyses and pattern recognition techniques on 2D images (e.g., Bandeira et al., 2012). Since a few years, new CDAs based on 3D models are being developed (see, e.g., Salamunićcar and Lončarić, 2010).

Our objective is to develop and test against existing methods an automatic CDA using a new approach based on the discrete differential properties of 3D meshes. The method (Kudelski et al., 2010, 2011a,b) produces the feature lines (the crest and the ravine lines) lying on the surface. It is based on a double step algorithm: first, the regions of interest are flagged according to curvature properties, and then an original skeletonization approach is applied to extract the feature lines. This new method can help the detection of impact craters as they are characterized by cyclic feature lines. Thus a specific filtering step has to be developed in order to provide a robust and efficient method for the extraction of impact craters.

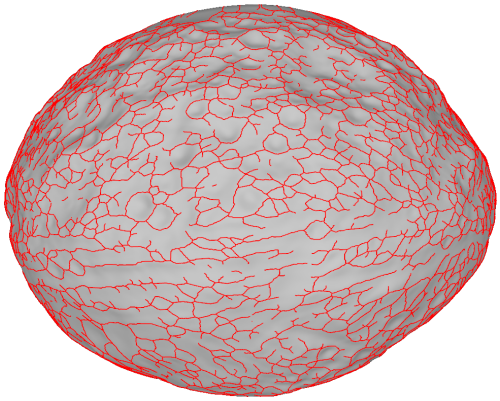

Figure 1: Automatic detection of feature lines on 3D meshes of the asteroid Vesta, using algorithms developed within our teams.

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