AUTOMATIC CRATER DETECTION USING DEM AND CIRCULAR COHERENCY ANALYSIS – A CASE STUDY ON SOUTH AMERICAN CRATERS

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Introduction: Considering the fine resolution and worldwide coverage of digital elevation models (DEM) available through the Shuttle Radar Topographic Mission (SRTM), an algorithm of automatic detection of circular patterns becomes a valuable tool for pre-selecting potential images with impact craters. As they have quasi-circular shapes, the majority of detection methods are based on the presence of such geometries [1]. However, these features can be severely masked by means of natural geologic process, such as degrading and erosion, meaning that there are craters which are no longer circular or continuously depicted.

The Hough transform (HT) is a standard technique used to detect circular edges in image processing by computing another image in a two-parameter domain. Basically, the original data is summed along straight lines that are uniquely determined by the line slope and distance to the origin. This is computed in such a way so that the transformed image in the parameter domain enhances the presence of circular shapes. In the circular HT (CHT) variant, the data is no longer summed along straight lines, but along circles. In this case, the domain is parameterized by the two coordinates of circles centers. However, as craters loose their original geometry due to erosion, the circular transformed image produces insufficient results to identify complex craters.

Method: One way to improve the results of the circular HT is to substitute the operation of summation by a more sophisticated technique called semblance [2], which is a measurement of coherency of data. The coherency analysis provided by the semblance is often used in seismic exploration to estimate seismic velocities. The semblance depends on parameterized templates- typically, hyperbolic curves for seismic problems. For the crater detection approach circles were employed. As an additional feature, the semblance measure along a curve uses a tubular neighborhood around it, meaning that any shape close enough to a circle is going to be detected, including elliptical curves and deformed circles. Also, non-coherent data along a line do not degrade the overall coherency, implying that pieces of circular edges of craters are going to be detected likewise.

Results: a specifically tailored algorithm and the software for crater detection based on circular coherency analysis were designed as part of this work. The performance of the algorithm was tested against sections of a 12Gbytes SRTM (90m) mosaic of South America (SA) (this work) and ASTER (15m) DEMs. Several areas were tested in SA, but a particular case was made for the Monturaqui crater in Chile, which has a diameter of 460m. Although a few false positives were produced, the crater was successfully detected by the technique.

Conclusions: By aggregating coherency analysis by means of semblance measurements, the circular HT becomes more robust, and proved able to detect circular and quasi-circular structures as well as structures with missing pieces in many cases studied in SA, including Monturaqui.

References: [1] Magee, M. et al., 2003. Abstract #1756. 34th Lunar & Planetary Science Conference. [2] Neidell, N. S. and Taner, M. T. 1971. Geophysics 36: 482–497.