AUTOMATIC ANALYSIS OF CRATER GEOMETRES. Chaitanya Bagaria[1] and Tomasz. F. Stepinski[2], [1]Dept. of Computer Science, University of Houston, 4800 Calhoun Rd., Houston, TX 77204, USA. [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058, USA. (cbagaria@uh.edu, tom@lpi.usra.edu).

Abstract: A topography-based algorithm that decomposes an impact crater into its floor, wall, and rim is proposed as a tool to expedite analysis of spatial variations in crater geometry. For each crater the algorithm produces a polygon-based, GIS-compatible map of craters components. Running the algorithm over the existing database of Martian craters creates a new database available for fast quantitative analysis of spatial changes in crater geometries.

Introduction: Impact craters on Mars are valuable features for studying issues such as geologic stratigraphy, degradational processes, regional variations in geologic material, and distribution of subsurface volatiles. In order to utilize craters for such studies a large databases of their locations and morphological properties are needed. Until recently, construction of such databases was done manually requiring a significant effort. Recently, automatic methods for cataloging Martian craters was developed [1] and the first machine-produced global catalog was created [2]. However, machine-created catalog lists only basic properties of craters: their positions, diameters, and depths. Calculating other crater properties still need to be done manually or using an interactive software [3]. Thus, the full benefit of automation is not fulfilled until such properties are also calculated algorithmically.

In order to continue our effort to fully automate crater detection and analysis we have develop an algorithm that divides a crater into its most prominent parts: its floor, the walls, and the rim. This needs to be view as the first step, to be followed by development of additional algorithms for calculations of other features associated with the craters (for example ejecta).

Method: Our algorithm is based on the technique of segmentation-based supervised classification. It's based on our previous work [4], which, in turn, was an extension of the technique [5] developed to auto-map terrestrial physiography. For a given crater, the input data is raster centered at the center of the crater and containing elevation data for a region extending outwards to about twice the diameter of the crater. We use crater database [2] and the global MOLA 128 pixels/degree mosaic to extract those rasters. The first step is to calculate three terrain attributes (slope gradient, surface texture, and local convexity) for each pixel in a raster; these attributes are used to classify each pixel into one of 16 physiographic classes [5]. The second step is to use the physiographic map to divide the raster [4,6] into segments – multi-pixel regions of approximately uniform class. The third step is to classify [7] these segments into one of four classes (crater floor, wall, rim, and inter-crater region), using a supervised classification algorithm. Supervised classification requires a training set – segments located in a small number of crater-containing rasters for which class label was assigned manually; this information is used to construct a classifier – function that assigns a class to segments in all other rasters. Running a classifier over a crater-containing raster produces the decomposition of a crater into its three constituent parts. In the final step we use a simple rule-based algorithm to modify the classification when it produces results that are consistent with topography but inconsistent with our knowledge of what the crater is supposed to look like.

Results: At present our calculations are basically a proof-of-concept demonstration. We have selected 23 craters having diameters in the range of 15-30km and relatively simple interior morphologies. We use rasters corresponding to three craters as the training set, and applied the classifier to the remaining 20 craters. It only takes about 1 minute to run an algorithm for one crater. Figure 1 shows an example of the results produced by our algorithm. This example is typical, inasmuch as we never get a rim that totally encircle the crater, but it is also atypical because the floor and the walls are especially symmetric. We envision a following application: one can use the floor and walls regions as masks to extract data (area, slope, etc) for those components. Such data extracted for a large number of craters can be used to search for spatial variability in, for example, the ratio of floor/walls area, or the steepness of the walls.

Discussion: Global-scale trends in crater geometry can provide information about many processes on Mars, but manual extraction of such data is not economically feasible. Automating the extraction process is desirable. To this end we are starting to develop algorithms that can perform such extraction. Our first goal is an automatic decomposition of craters into three parts: floors, walls, and rims. Even this limited goal presents great computational challenges. At present we have a working prototype of such algorithm that demonstrates a feasibility of automated approach. Further study is needed to assess accuracy of the decomposition and to identify specific issues that can be addressed using a database that our algorithm can create.

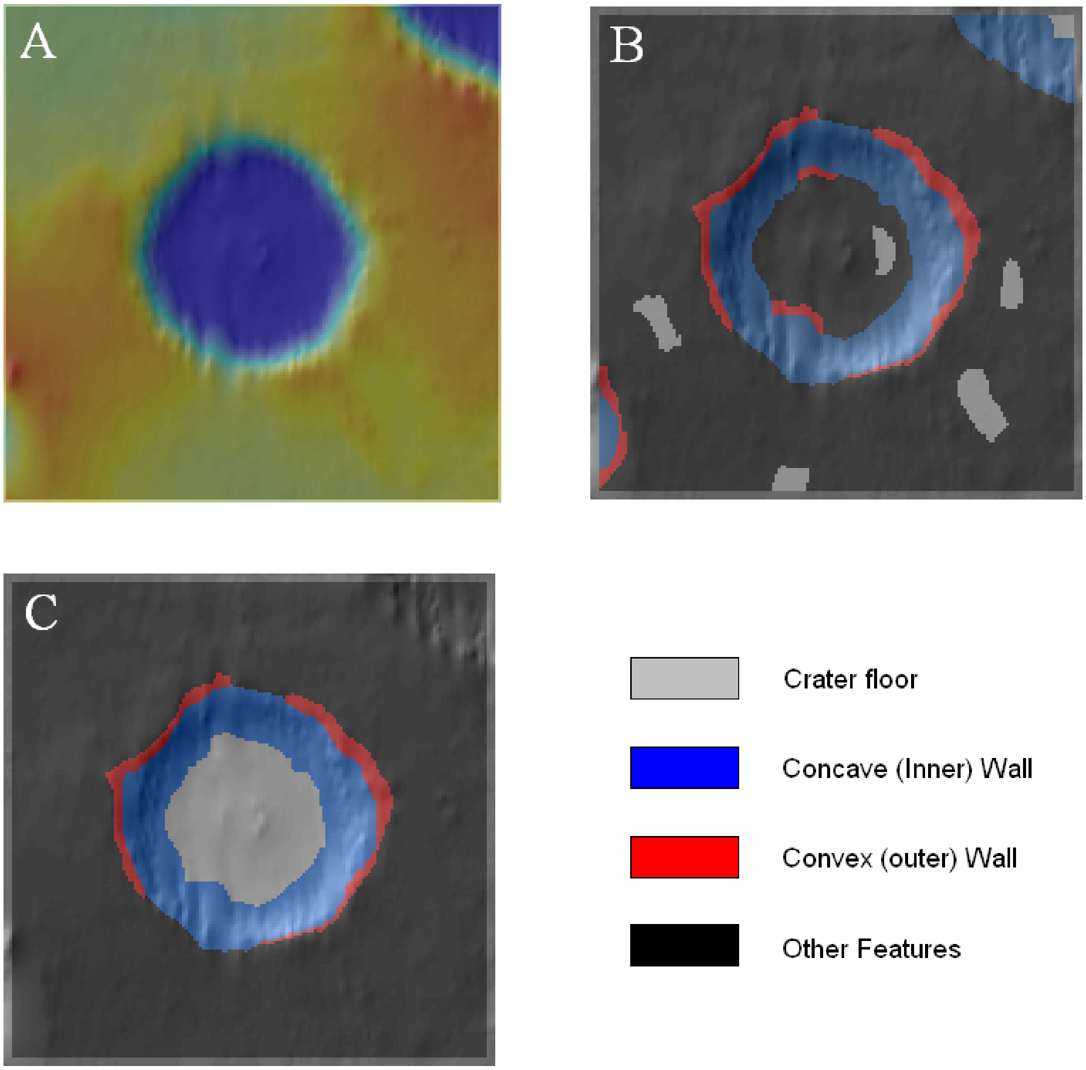

Figure 1. Sample map of a 39 Km diameter Martian crater. (A) Elevation map draped over shaded relief. (B) Map showing predictions of the classifier. (C) The final map after filtering out misclassifications. Legend shows final class labels.

References:

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