Crater Profile Analysis using High Resolution Laser Altimetry Data Sets. J. Montgomery[1] and J. McDonald[2], [1]Georgetown University, Washington, DC 20057, jmontgomery@cs.georgetown.edu, [2]DePaul University, Chicago, IL 60604, jmcdonal@cs.depaul.edu.

Introduction: Impact craters play an important role in planetary chronology and geomorphology. Analyzing impact crater morphological features, such as crater diameter and frequency is a critical step in determining the age of celestial bodies[1]. However, the accuracy of impact crater measurements can vary depending on the type of remote sensed data used and on the method used to measure impact crater features. Such efforts have been greatly aided by the new topographical data sets from planetary orbiting satellites such as the mars and lunar orbiters [2], which have provided maps as detailed as 1024 px/degree. Unfortunately current tools are either unable to use this new dataset at all due to the sheer volume of data or are unable to allow feature identification and analysis at interactive speeds. We present a novel approach which integrates feature exploration with precise crater profile measurements using high-resolution laser altimetry (128, 512 or 1024 px/degree) data sets rendered at interactive frame rates on consumer graphics hardware.

Impact crater morphometry is essential in studying landform processes of planetary bodies. For example, crater formation and size/frequency distribution rely on measurements of feature sizes and slopes on the body's surface. These measurements can be derived either from stereographic images obtained from visual spectrum cameras or from altimetry data products which have traditionally been of much lower resolution. The present work focuses on altimetry products because the accuracy and resolution of the current data sets provided by NASA are competitive with the higher resolution stereographic data previously available. Morphometric analysis based on height measurements derived from low resolution data can differ by as much as ± 250 meters when compared with high resolution data products[3] and slope calculations can suffer dramatically from such inaccuracies.

The primary tool for measuring crater morphology is the crater profile, which is a cross section plot of a crater's elevation and diameter. Crater profiles can be generated manually from altimetry data. Unfortunately, one of the most common methods for using altimetry data uses an add-on tool for ARCGIS [4]. This system requires importing a low-resolution shade-relief terrain model which is rendered offline. Therefore the computations are often based on data from a secondary image rather than from the original altimetry data set.

mVTK is a visualization and data exploration software package that dynamically renders visualizations of high resolution digital terrain models in gridded record datasets (GRD) at interactive speeds. It does this by exploiting the power of consumer graphics hardware [5]. To facilitate the use of mVTK for impact crater morphometry, we have extended mVTK with the addition of tools for crater profile measurements. These measurements are computed directly from the high-resolution LOLA/MOLA GRD datasets based on user input with a mouse.

The system provides equidistant cartographic projections using the full-resolution gridded data files provided by NASA and provides both false-color and shade-relief visualizations. These projections are interactively rendered allowing the user to explore the planetary surface in real-time [6]. Once the user has chosen the desired planetary feature, the user can select a linear path along the surface to generate a crater profile. The profile generated by mVTK uses the same high-resolution altimetry data that was used for cartographic projection and is also computed and rendered using graphics hardware.

To compute distances and slopes, the user simply selects two points on the profile graph. These points are mapped back to the original unmodified high-resolution gridded data and both the longitudinal and vertical distances are computed. These distances allow the following crater measurements which are essential to the analysis of crater formation:

- Rim-to-rim and rim-to-peak distances
- Rim height
- Crater floor and peak widths
- Crater wall and peak wall slopes

These measurements are essential to impact crater categorization and to the analysis of crater formation, such as, simple crater to complex crater transitioning characteristics [7]. Measuring crater features are in important part of chronology and crater morphology analysis. This presentation will demonstrate how mVTK provides a method that directly uses high-resolution altimetry data to improve the accuracy of such measurements.

References:

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