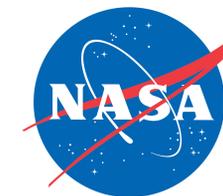


Rock Identification Toolkit (RockIT): A Graphical Program for Labeling and Analyzing Rock Scenes

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Introduction

The Rock Identification Toolkit (RockIT) is a mature, cross-platform, graphical program designed to help geologists rapidly and accurately label rocks and particles in images. As images are labeled, RockIT reports both individual rock (or particle) statistics and overall scene statistics.

Benefits

Determining rock size and distribution is an onerous task. Analysis of 4,300 rocks from the Pathfinder landing site took five students an entire summer. Viking data took years to analyze.

With RockIT, MER scientists have been able to collect and analyze scene statistics for both Spirit and Opportunity panoramic and microscopic imager spherule images using far fewer resources and in less time. Golombek et al. (2005) [2] used RockIT to estimate rock size and area coverage for several regions within Gusev crater. This summer two students used RockIT to label 39,674 rocks in two panoramic images.

Portability

RockIT was written in a combination of C and C++ to be extremely portable. It uses the cross-platform wxWidgets GUI toolkit [4]. Currently, RockIT runs on Mac OS X, Microsoft Windows, and Linux.

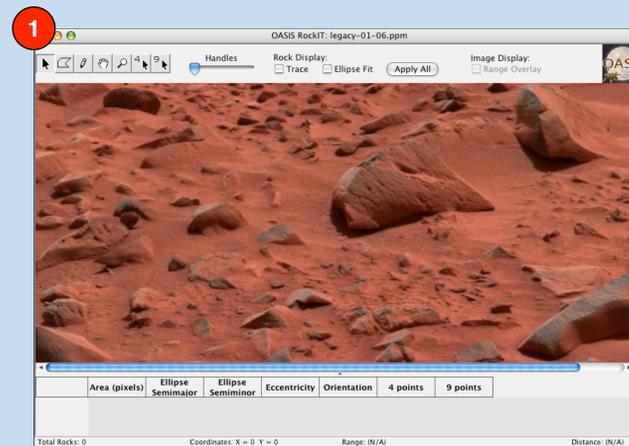
References

[1] Fitzgibbon A. W., Pilu M. and Fisher R. B. (1999) Direct least-squares fitting of ellipses. *Pattern Analysis and Machine Intelligence*, 21(5).

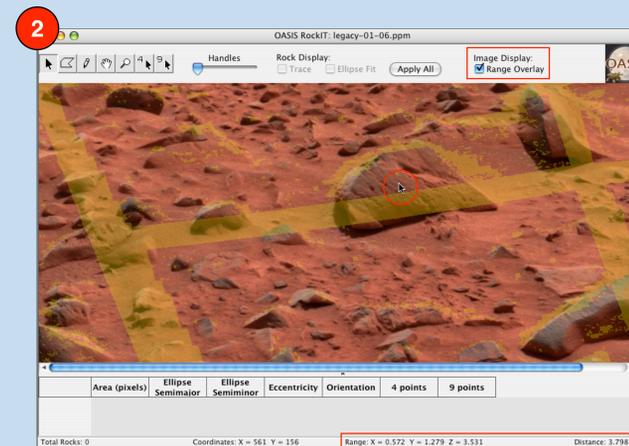
[2] Golombek M. P. et al (2005) Assessment of Mars Exploration Rover landing site predictions. *Nature* 436, 44-48.

[3] Halír R. and Flusser J. (1998) Numerically stable direct least-squares fitting of ellipses. *Proceedings of the 6th International Conference in Central Europe on Computer Graphics, Visualization and Interactive Digital Media (WSCG)*.

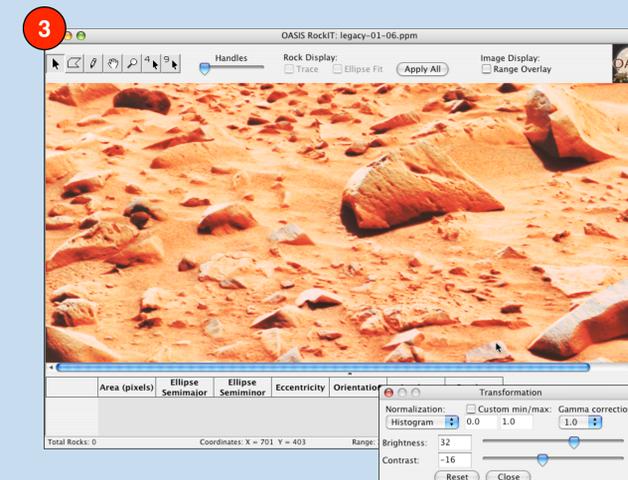
[4] wxWidgets, <http://www.wxwidgets.org/>



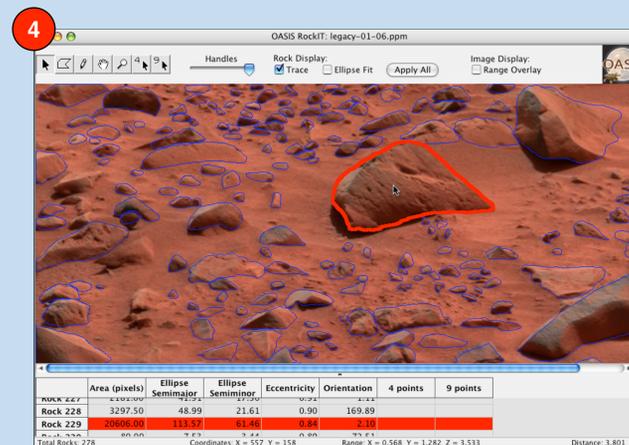
RockIT loads image data in a variety of formats including JPEG, TIFF, PNM, and the MER Planetary Data System (PDS) format. Above is a portion of the Legacy panoramic image (23348x3600 pixels) taken by the Spirit rover. Filters L2, L5, and L6 were used for the red, green, and blue channels, respectively.



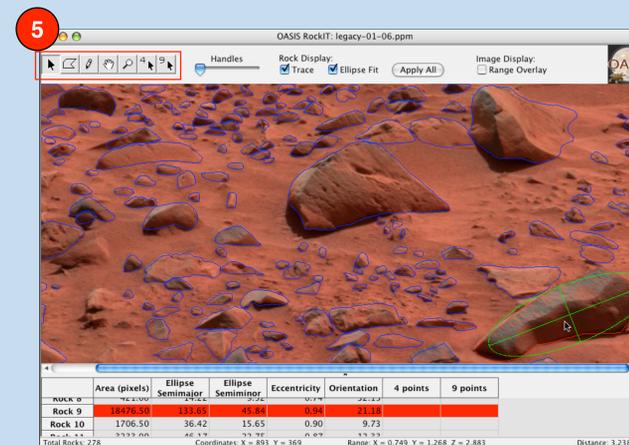
RockIT can overlay range data derived from stereo image pairs. The (x, y, z) coordinates of and the distance to each pixel (in meters) are displayed as the mouse pointer passes over the pixel. The translucent yellow indicates pixels where no range data is available.



RockIT can enhance images in real-time (continually). We applied a histogram equalization, increased the brightness, and decreased the contrast of the image above.

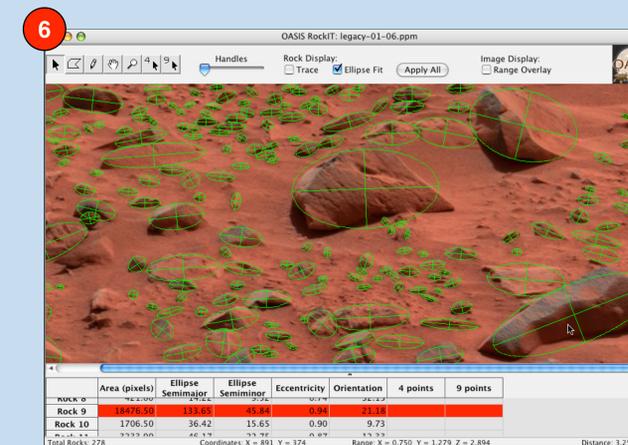


RockIT's rock finding algorithm calculates initial traces (boundaries) for rocks by arbitrating (combining) Sobel and Canny edge detectors at multiple scales. This initial, machine-assisted, rock determination is not perfect and becomes less so for certain classes of images (e.g. scenes with high dust deposition or images with low contrast).



To improve upon inaccurate rock detections, RockIT provides a set of paint program like editing tools.

For each trace, RockIT reports its area in pixels, fits an ellipse to the trace perimeter, and reports ellipse major and minor axes, eccentricity (roundness), and orientation.



To fit an ellipse to a set of points, RockIT uses an efficient, numerically stable, direct, least-squares conic fit algorithm [1, 3]. From the user's perspective, ellipse fits are instantaneous. In the image above, we turned-off range overlay and trace display and turned-on display of the fit ellipses.