Researchers develop algorithm to identify individual grains in planetary regolith

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Instruments on the Curiosity Mars rover not only measure the chemistry of rocks, elemental abundances of soils and wind speeds, but also take an incredible number of images from both mast-mounted cameras and up-close imaging systems mounted to robotic arms. The process of analyzing soil images can be daunting, particularly when there are thousands of images and when the particles can be on the order of only 5-10 pixels wide. A team of researchers, led by Suniti Karunatillake at LSU's Department of Geology and Geophysics, and including Stony Brook University, USGS-Flagstaff AZ, and Rider University, developed an image analysis and segmentation algorithm specifically to aid planetary scientists with this very basic, but often difficult, task.

Planetary scientists use images to identify the distribution of grain sizes of large-scale (centimeter or larger diameter) rocks and small-scale (less than 1 cm) grains. These grain sizes tell scientists about the processes that distributed the particles from their source regions to where they are now. For example, were they derived from a water source, blown by wind, or show hydrodynamic sorting?

The algorithm, implemented in Mathematica, uses a variety of image processing steps to segment the image, first into coarser (foreground) and finer (background) grains. The image is then further segmented until most grains are outlined. The code processes a single image within 1 to 5 minutes.

The semi-automated algorithm, while comparing favorably with manual

(human) segmentation, provides better consistency across multiple images than a human. The researchers are exploring the use of this algorithm to quantify grain sizes in the images from the Mars Exploration Rovers Microscopic Imager (MI) as well as Curiosity's Mars Hand Lens Imager (MAHLI). The grain size distributions identified in those images have the potential to reveal subtle trends with composition not considered previously. Ability to identify most of the grains in images also makes detailed, area-weighted, sedimentology possible. Applications extend to terrestrial data from less accessible sites such as deep lake basins or undisturbed river bed sediments.

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