Automated Boulder Detection and Measuring in HiRISE images

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Abstract #2437

Introduction

Images taken by the High Resolution Imaging Science Experiment (HiRISE) show that meter-scale boulders, as observed by landers and rovers, are present across the entire surface of Mars [1], [2]. Quantifying estimates of these boulder populations, including their size and location, can inform Martian pedogenesis, surface weathering, impact processes, and mass wasting processes [3], [4]. However, manual measurement of boulder populations is time intensive, and cannot be applied at large scales (e.g. more than a few square km of surface area). To facilitate this, we have developed a Python-based algorithm to automatically identify, locate, and measure boulders on the martian surface. This set of tools and programs is collected in a python library called the Martian Boulder Automatic Recognition System: MBARS. This is designed as a publicly available (via online source e.g. GitHub) toolset to enable science and allow modification and improvement by the larger community.

Methodology

• Modeled after method in Golombek 2008 [1]
• Shadowed areas identified via intensity thresholding (Figure 2,4)
• Partitions the image and North

Performance and Verification

• On 16 GB, 4 Core 3.6 GHz processor, full image processes in ~10 hours
• Handles data errors smoothly

Algorithm tested against existing datasets: o Measurements by other algorithms [1], [2] o Manual measurements (Figure 6,7) o Objects of known size (landers, rovers, and measured rocks)
• 3 sections of PSP_007718_2350 are main test dataset

• Testing emphasizes accuracy with populations and individual objects
• Cumulative Fractional Area, Size-Frequency distributions: key population comparators

Application

• Boulder width and height interpreted from measured values, precise sampling of penumbra, low gamma = intense stretch
• Rotate Image: Orienting image in sun direction simplifies ellipse fitting
• Ellipses fit with Orthogonal Distance thresholding (Figure 2,4)
• Modeled after method in Golombek 2008 [1]

Algorithm Workflow

Partitioning: improves speed, user can control level of partitioning
• Gamma Filter: Removes low-value pixels, precise sampling of penumbra, low gamma = intense stretch
• Rotate Image: Orienting image in sun direction simplifies ellipse fitting

Conclusions & Future Work

• MBARS tends to miss smaller boulders and overestimate boulder diameters
• False positives not observed in images
• Comparison with published algorithms promising
• Will fully explore parameter space to identify most accurate settings
• Cut processing time down to ~1 hour o Parallelization is key step

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References