Rock Detection and Accurate Boundary Localization Through Non-Learning Based Superpixel Optimization

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1. Introduction

Rock detection is essential for lunar rover navigation. Moreover, accurate rock outlines are helpful in creating maps of the moon. However, accurate rock detection and outline localization are difficult to achieve due to the diversity of rock shapes.

Related Work

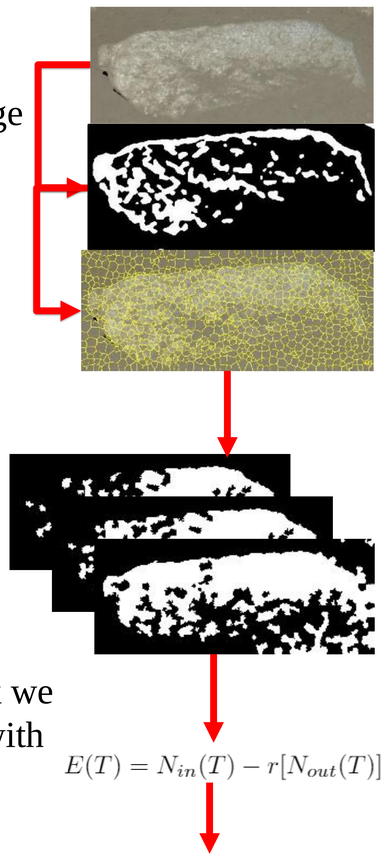
- Recent methods have used superpixels to detect rocks and their outlines through learning algorithms, but their detection accuracy was limited due to lack of lunar landscape data.
- Older methods based on edge detection have achieved beter detection accuracies, but the quality of their boundary localization was lacking.

Our Work

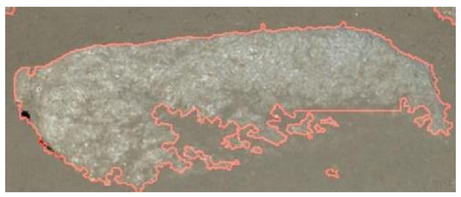
The goal of our research is to combine the previous works in order to create a method that can achieve both accurate rock detection and boundary localization through a non-learning method to be used in lunar rover missions such as the Iris Rover Mission.

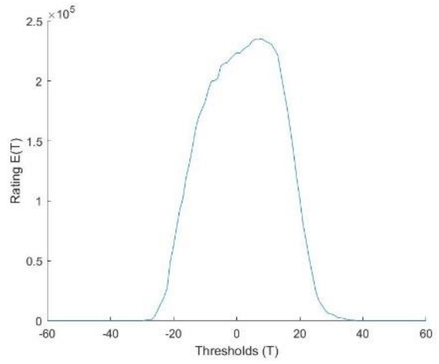
2. Method

- **Edge Based Rock Detection**
  We use edge detection alongside a range filter in order to detect the rocks in an image and estimates their rough shape.
- **Superpixelization**
  We use the SLIC algorithm to create a superpixel segmentation of the rock image to create accurate outlines.
- **Thresholding**
  Using the superpixel segmentation we can create different binary images through thresholding.
- **Optimization**
  We rate each binary image based on its resemblance to the rough shape of the rock we found before and select the binary image with the best rating. We repeat the process on different filtered versions of the image to ensure a better outline quality.



$$E(T) = N_{in}(T) - r[N_{out}(T)]$$





3. Results

- We tested the method on 15 images from the Chang'e 3 lunar rover mission, 7 of which are from the panoramic camera (PCAM) and 8 are from the terrain camera (TCAM).
- We achieved a detection accuracy of 81.03% on the PCAM images and 95.03% on the TCAM images.

4. Future Work

- Further testing/evaluation will be done during the Iris Rover Mission.
- The superpixelization process should be made more efficient to make the performance faster.
- Improvements to allow for better accuracy in low quality images.

5. Acknowledgment

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