Image Processing Algorithms for Improving Planetary Exploration and Understanding

Ali Pouryazdanpanah

Advisor: Emma E. Regentova

Department of Electrical and Computer Engineering,

University of Nevada, Las Vegas (UNLV), Las Vegas, NV 89154, USA

Objectives

- To design a fully automated tool-set that allows to detect and extract the sky region in planetary images.
- To develop the new method for rock segmentation in planetary stereo images.
- To develop the new method for shadow detection in planetary images.

Background

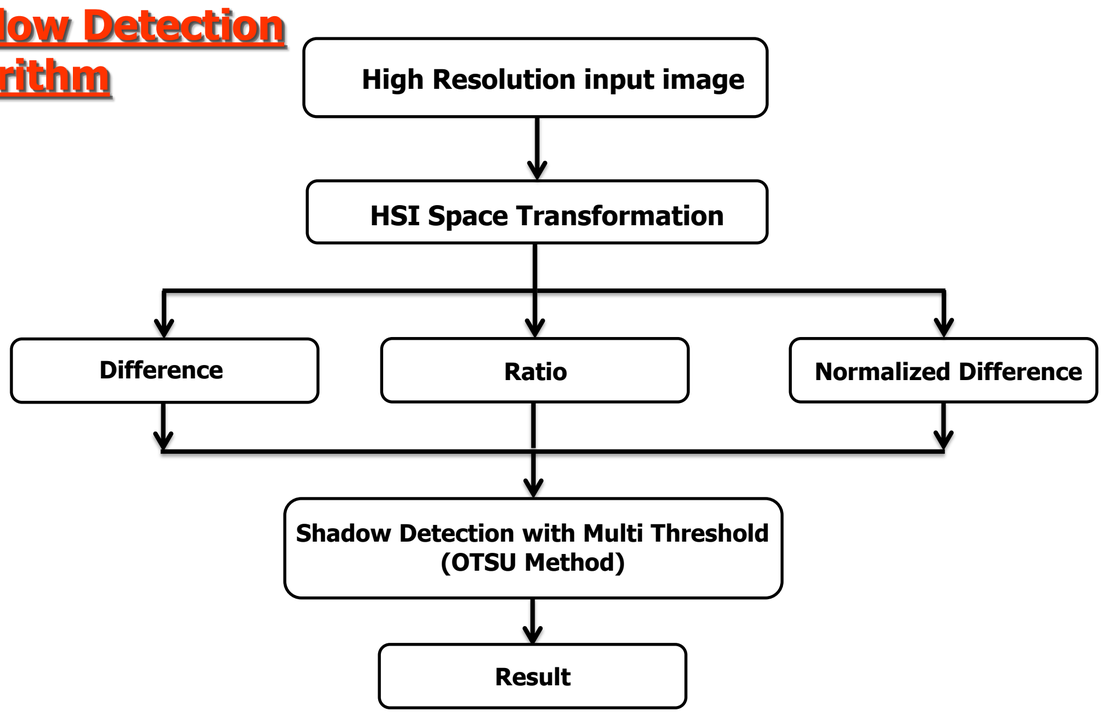
- NASA's Mars exploration rover mission (MER) and Mars science Laboratory mission (MSL) are ongoing robotic space missions involving three rovers , exploring the planet Mars.
- The most important tasks of their missions are route planning, path finding, and geologic analysis demand the identification of observed rocks.
- For route planning and path finding, (1) sky region must be detected and subtracted from the whole image. (2) rocks must be detected before producing rock maps at the landing sites. (3) Shadows should be detected to help us estimate the rocks volume.
- There is need for a fully automated method for handling the three tasks mentioned for route planning and path finding.
- All the previous sky detection methods didn't have the ability to work on grayscale images, they use the color information to come up with a good method for sky detection

Rock Segmentation using Improved Active Contour method for stereo images.

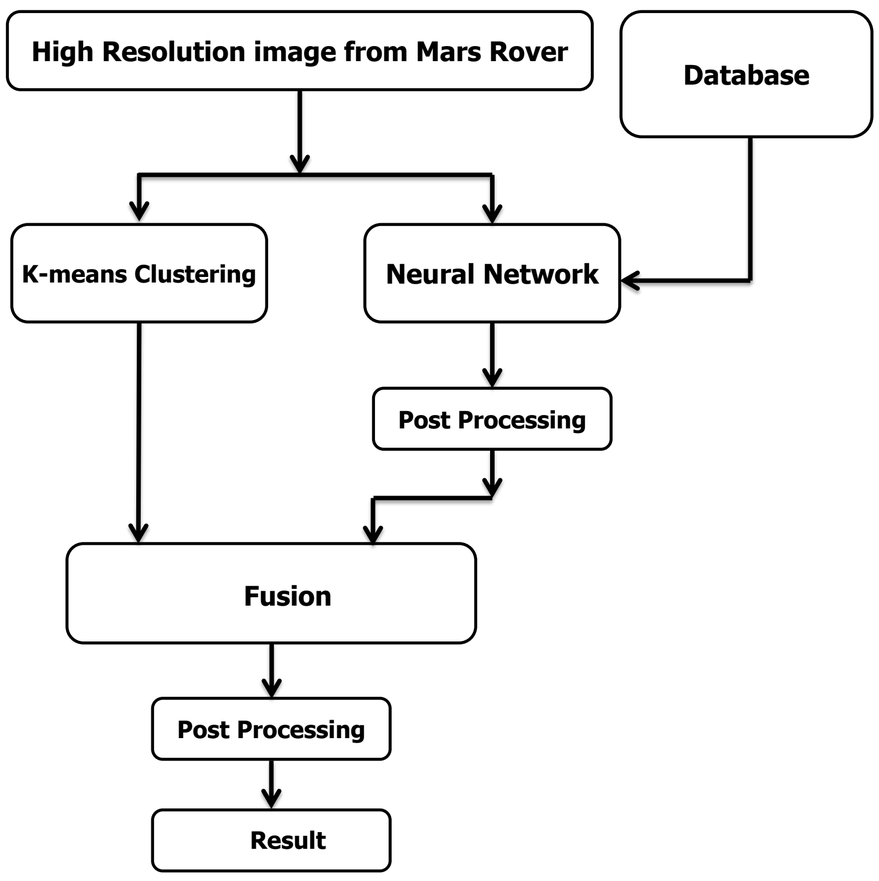
Step 1 Depth information normalization.

Step 2 Segmentation of the stereo images using extended active contour method.

Shadow Detection Algorithm



Sky Detection Algorithm



Sky Detection Results

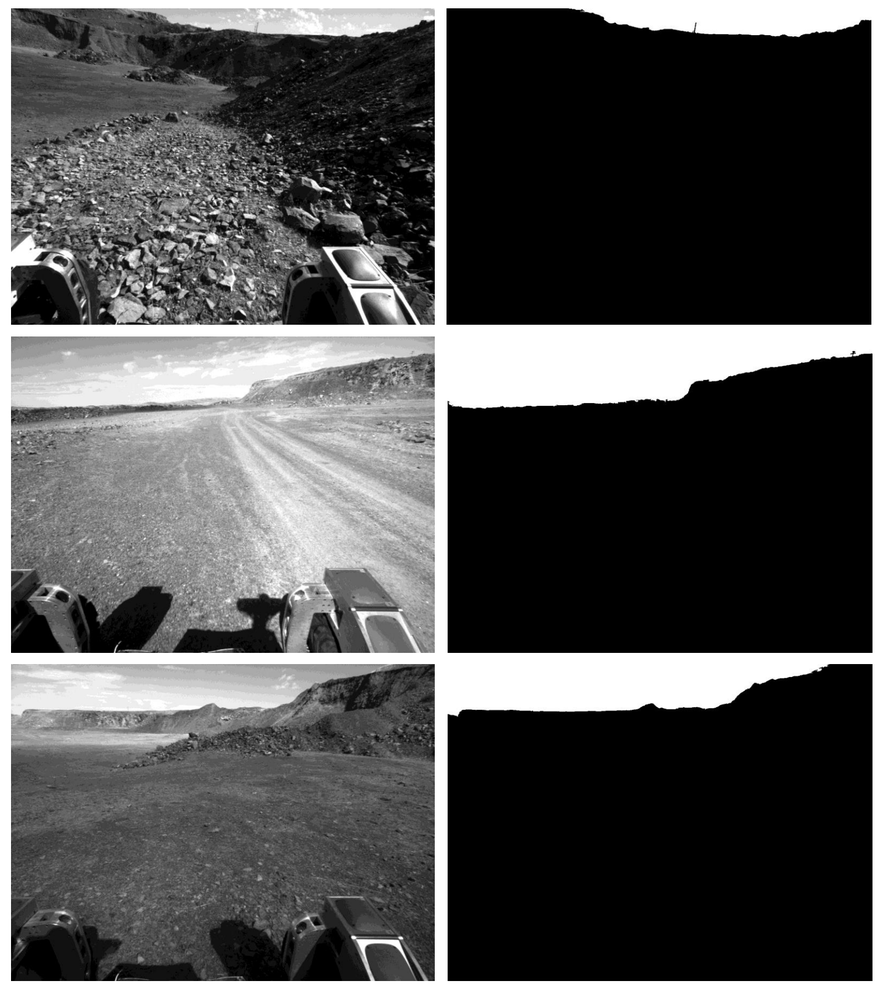


Fig. 1:
Raw image(left).
Detected Sky (Right).

Shadow Detection Results

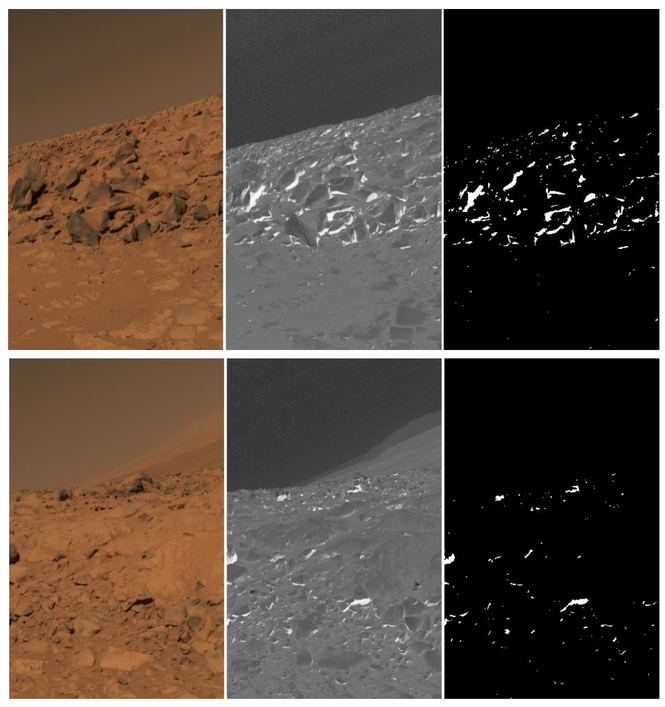


Fig. 2:
Raw Image(left).
Normalized Difference Index Image (middle).
Detected Shadows (right).

Segmentation Results

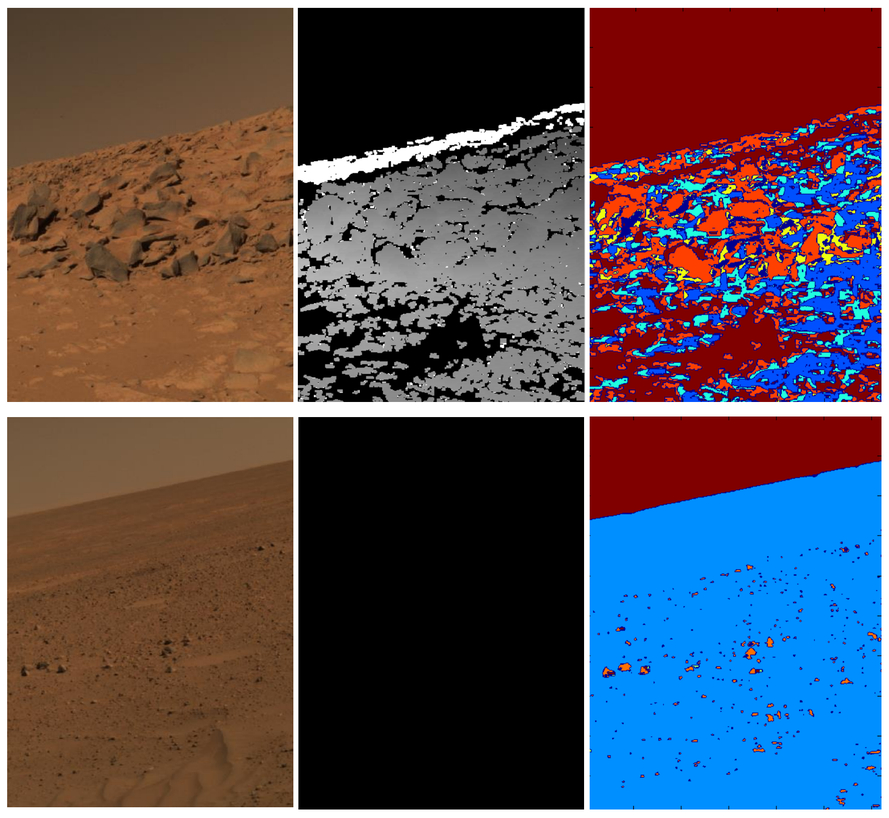


Fig. 3:
Raw Image(left).
Depth Information (middle).
Segmented Image (right).

Conclusions

(1) The new sky detection algorithm is proposed for very high resolution grayscale planetary images. Using k-means clustering combined with Neural Network allows to extract the sky region accurately.

(2) The improved active contour method is proposed to segment the stereo planetary images (color+depth).

(3) The multi thresholding method used to detect the shadows in planetary images.

(4) The executable application (NASA Demo App) developed for both Windows and Mac operating systems.

Acknowledgement

This material is based upon work supported by NASA EPSCoR under Cooperative Agreement No. NNX10AR89A