Depth Estimation Based on Monocular Image for the Moon With Machine Leaning and Shape-From-Shading

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1. Introduction

Digital Terrain Models (DTMs) of the lunar surface are widely used for lunar exploration planning and studies of topography and geology [1]. LRO NAC DTMs with the highest resolution (~2 m/pix) cover small percentage with 470 pieces [2] . This is due to the time required to create DTMs by manual and the few data available to create them [3].

The purpose of this study is to generate high-resolution DTMs automatically with limited data. This research proposes a method to complement LRO NAC DTMs by generating the almost the same resolution using Machine Learning & Shape-From-Shading (SFS) [4]. The goal of this study is to implement a pipeline generate DTMs that combines machine learning with SFS and evaluate the generated DTM.

2. Methodology

This study uses a Pix2Pix [5] as machine learning model. This model can transform the type of image by learning the relationship between two sets of images. DTMs can be created from abundant visible images by training Pix2Pix on both DTMs and visible images.

SFS is a technique for estimating the shape of an object from a single shaded image. We improve DTMs generated from Pix2Pix adapting SFS.

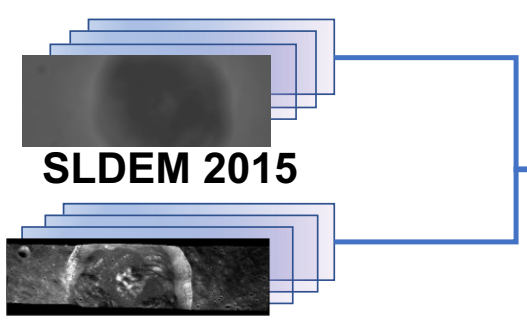

Figure 1. Pipeline of Methodology

3. Current Status

Figure 2 shows the process of creating Pix2Pix training data. This research select SLDEM 2015 [6] & LRO NAC Orthoimage [7] as dataset. First, LRO NAC Orthoimages are downsampled to match the resolution of SLDEM 2015. Next, the images are cut and shaped to 256x256 pixel. Finally, histogram smoothing is applied to images and aligned into a 512x256 pixel image.

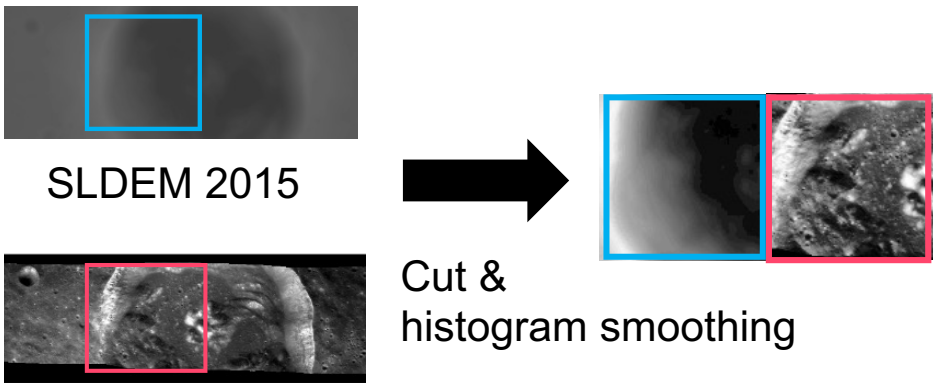

Figure 2. Preprocessing dataset

4. Schedule

Milestones	2022			2023		
	10	11	12	1	2	3
Preprocess dataset						
Implement & evaluate machine learning model						
Evaluate SFS experiment						
Write a LPSC abstract						
Write a gradiation thesis						
Prepare for GT presentation						
Prepare for LPSC Presentaion						

1/10 LPSC abstract deadline
1/20 GT draft deadline
2/15,16 GT Presentation
3/13 ~ 17 LPSC Presentation

References

[1] Barker, M. K., et al., A new lunar digital elevation model from the Lunar Orbiter Laser Altimeter and SELENE Terrain Camera, 2016. doi:10.1016/j.icarus.2015.07.039
[2] Henriksen, M., et al., LROC NAC Digital Terrain Models: Production and Availability, 2020. In Proceedings of the Lunar Surace Science Workshop, virtual meeting, 28–29 May 2020; LPI Contribution 2241. p. 5084.
[3]Onodera, K., et al., Resolution enhancement of DEM of the lunar surface using machine learning, 2020. doi:10.20637/JAXA-RR-19-006/0003
[4] Horn V. K. P. & Brooks M. J., SHAPE from SHADING, (London, MIT Press,1989).
[5] Isola, P., et al., Image-to-Image Translation with Conditional Adversarial Networks, 2016. doi:10.1109/CVPR.2017.632
[6] http://imbrium.mit.edu/EXTRAS/SLDEM2015/
[7] https://wms.lroc.asu.edu/lroc/rdr_product_select