SITE SUITABILITY ANALYSIS FOR PROSPECTIVE LUNAR COLONIES USING VARIOUS DEM DERIVATIVES AND LAVA TUBES SITES IDENTIFIED USING MACHINE LEARNING. Arya Pratap Singh and Ananya Srivastava, Indian Institute of Remote Sensing - Indian Space Research Organization, Dehradun.

Introduction: With the advancements in space technology, space colonization is no longer a far-fetched sci-fi dream. The present study has used the Digital Elevation Model of the poles of the Moon to perform site suitability analysis for prospective colonization in the region. This paper proposes evident sites where lunar colonies can be established inside a lava tube structure with close proximity to a landing site and on-ground base camp. The polar regions of the Moon are of significant importance due to the presence of surface water ice and volatile components in Permanently Shadowed Regions (PSRs) and the low obliquity of the moon indicating the existence of Predominantly Sunlit Regions at the poles which can be used to harness solar power. The lava tube structure will provide protection from the uninhabitable environmental conditions like cosmic radiation, toxic lunar dust and meteorite impacts. The DEM derivatives of hillshade, surface slope and topographic roughness are used for finding the Permanently Shadowed Regions (PSRs), Predominantly Sunlit Regions, which in turn are used to identify suitable sites for landing and on-ground base camps establishment.

Lava tubes of significant dimensions in the polar regions are identified using convolutional neural networks (CNN) on the mosaic of lunar poles. CNN works by implementing a hierarchical neural network model using a convolution patch over the image. The layers of the neural network learn the trends with repetition and try to digitally memorize. The learning uses a backpropagation algorithm, which is evaluated by a cost function.

CNN was applied to the high resolution mosaic created from the WAC of LRO payload in LOLA. The CNN identified the lava tubes as a separate class, and the accuracy was determined based on the cost function. Further, the learnt model was applied on the new areas for identifying the similar signatures of lava tubes, and these sites were considered suitable.

The XGBoost algorithm was used on DEM derivatives which uses a gradient boosting framework, which performed well for the structured data used in DEM derivatives. The derived areas from both the learning models came out to be of interest for prospective lunar colonies. The XGBoost algorithm works on ensemble learning techniques. Multiple decision trees are used for improving the overall accuracy of the predictable result.

After the suitable areas were identified using CNN and DEM derivatives, the XGBoost algorithm was used for evaluating the accuracy of the suitable sites found using the algorithms mentioned.

Data: The data products used in this study are derived from the Lunar Reconnaissance Orbiter (LRO) of NASA's Lunar Orbiter Laser Altimeter (LOLA) mission. The Digital Elevation Model of both poles of the moon and a mosaic of the images generated using Wide Angle Camera (WAC) of LRO payload on LOLA.

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