LCDNet: An Innovative Neural Network for Enhanced Lunar Crater Detection Using DEM Data

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Lunar craters are essential for spacecraft landing navigation and lunar exploration missions. Deep learning holds great promise in the crater detection task, but still faces some challenges. One major issue is that using incomplete crater catalogs to create the crater dataset, which negatively impacts the training of deep learning models. Additionally, deep learning models are prone to missing detections in overlapping crater scenes. To address these challenges, we propose a novel crater detection neural network, LCD-Net, with two key innovations. The first innovation is the fusion of a Reserved Negative Sampling (RNS) module, which alleviates the problem of incomplete crater annotation in the dataset and detects a large number of potential new craters. The second innovation is the addition of an Adaptive Non-Maximum suppression (A-NMS) module, which optimizes the detection of overlapping craters and reduces the miss rate. We use lunar digital elevation model (DEM) to construct the crater dataset for training and evaluating the detection model. The experimental results demonstrate that LCD-Net achieves recall rates to 96\% and 95\% on the validation and the test sets, respectively. These results are significantly better than the state-of-the-art methods. Furthermore, LCD-Net also ables to detect tens of thousands of credible new lunar craters that can be used as an expansion to existing crater catalogs, making them more suitable for deep-learning dataset annotation. Overall, our work provides an efficient and reliable solution for lunar crater detection.

Keywords: Lunar crater detection, Deep Learning, Lunar surface feature detection, Neural networks

