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MULTI-TYPE TERRAIN DETECTION AND EVALUATION ON PLANET SURFACE BASED ON DEEP LEARNING

Abstract

This paper proposes a deep learning-based method for detecting and evaluating multiple types of terrain to address the potential threats posed by the diverse and heterogeneous terrain on the planetary surface to the safety of rover landings. Landing detection is a necessary prerequisite for in-situ exploration and scientific research on planetary surfaces, and the assessment of mission landing sites is the key problem to be solved to land on planetary surfaces safely. Currently, the common engineering approach is for ground operators to screen safe terrain and select target landing areas, which requires manual involvement and lacks real-time. Future planetary landing missions will have higher autonomy requirements, and there is an urgent need to develop an online detection and evaluation algorithm for different terrains to ensure the safety of the landing mission. Since different kinds of terrain will present different texture, brightness, shadow and other features in the image, different feature extraction algorithms usually need to be designed for different categories of terrain at present, and there is a lack of a unified detection method. To address the above problems, this paper proposes a terrain detection and evaluation method based on deep learning, which uses the automatic feature extraction capability of convolutional neural networks to achieve the detection of different kinds of terrain, and then completes the landing point selection based on the terrain detection results. Since the quality and size of the dataset are crucial to the effectiveness of the deep learning method, and the unstructured characteristics of most of the terrain on the planetary surface increase the difficulty of labeling the data. Therefore, this paper introduces a weakly supervised learning method to automatically generate pixel-level annotations based on frame-level annotations to significantly reduce the cost of dataset construction. Firstly, a planetary surface terrain classification network model is constructed based on the planetary surface terrain classification dataset, and the coarse localization results of the terrain in the images are extracted using the class activation map. Secondly, the dense conditional random field algorithm and random walking method are used to improve the terrain detection results of the class activation map and generate the corresponding masks of the terrain. Then, the semantic segmentation network is trained to generate a comprehensive evaluation result of the terrain based on the prediction results of the network. Finally, the effectiveness and feasibility of this method are verified by testing on real planetary surface images.