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Automatic crater detection over the Jezero crater area from HiRISE imagery

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Impact craters are used to determine the ages of planetary surfaces. Absolute dating of meteorites or in situ geochronology provide a few essential reference points, but these techniques are rare and not yet applicable at the planetary scale. Therefore, impact crater counting techniques will remain the major tool to decipher planetary surface history. This approach requires a tedious mapping and morphological inspection of a large number of circular features to distinguish true and primary impact craters. The most complete database of Martian craters includes a catalog of more than 384,000 impact structures larger than 1 km in diameter. This database is considered to be complete for this diameter range. A requirement to determine young surface ages on Mars must include smaller impact craters, typically a hundred meters in diameter, found on the area of interest.

To access to the crater population of this size range at a planetary scale we built a Crater Detection Algorithm (CDA) trained on THEMIS images where impact craters larger than 1 km from the Robbins & Hynek database have been identified. Our model offer a true detection rate of 0.9. We then applied our CDA on the global CTX mosaic within the ±45° latitudinal band leading to ~17 million of detection >100m in diameter.

The ultimate goal of our work is now to automatically compile smaller impact craters (5m<D<100m) visible on HiRISE imagery dataset offering a resolution of 25cm/px. We trained our algorithm on a part of the HiRISE mosaic (NASA/JPL/MSSS/The Murray Lab) covering a part of the Jezero crater (E77-5_N18_0) where 1650 craters have been manually identified. A portion of this population of craters has then be selected in order to be sure to include the most confident impact features in the training dataset, finally resulting to 1624 craters over this entire image.

Our model has been applied over the entire HiRISE mosaic covering the Jezero crater where more than 27,298 craters >3m have been detected. In order to validate our results, we compared the detection obtained on 30 tiles of 960px x 960px randomly chosen on a part of the mosaic (E77-25_N18-25) which have not been included into the training dataset with a manual

identification, thus constituting the ground truth. For this purpose, we decided to categorize each tile according to the type of terrain mostly represented on each of them: rocky terrain, smooth terrain and dunes fields. We have also specified when the image exhibited some vertical stripes leading to the fourth category.

On rocky and smooth terrains, the CDA produce very good results: only 5% of detection on the average are false detection and 16% of craters on average have not been detected by the CDA. However, the CDA is less efficient on dune fields since 35% of detection are false detection and 15% of craters have not been identified. Finally, images exhibiting some vertical stripes significantly decrease the detection rate of the CDA since 56% of detection are false negative and 20% of craters have not been detected.