On-board eXplainable AI models for in situ Lunar and Martian images

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Introduction

Recent advances in AI make it possible to process images captured by on-board cameras in real or close to real time. For example, AI models can now generate 'bird eye views' from single landscape images [1]. This technique can be used to observe e.g. roads, buildings, etc., from a different angle than what the camera captures, overall allowing to construct approximate maps of the landscape in front.

By extension, the same process can be applied to photos taken elsewhere than on Earth. Such AI models can be trained to generate approximate maps from images captured in situ on the Moon or on Mars, where the landscape is quite different than on Earth, with support for visualizing elements like hills, craters, etc. At the same time, the success of an AI project depends on the availability and quality of the training data. To this end, we do have access to numerous geolocated in situ images collected by the Lunar and Martian missions or rovers, like Curiosity or Perseverance. Such data can be further coupled to high-resolution maps obtained by recent observation probes like e.g. Mars Express.

Thus, on-board AI models could provide robotic engines with support for estimating their position and/or direction autonomously, without even requiring a connection back to Earth, and where above landscape pictures can be compared with on-board maps.

During the MachIne Learning for AstroNomy project (MILAN, funded by the Luxembourg National Research Fund, we designed and trained Deep Learning models that process high-resolution astronomical images on devices with limited computational resources [2]. As such, we will leverage the knowledge gained in developing and deploying such models as to enable embedding novel functionality in robotic devices and extend their autonomy.

In addition, building trust w.r.t. the embedded solution(s) and software layers, AI included, is essential to the field of space exploration, specifically as to enable reliable operation and e.g. for/when remedying anomalies [3]. To this end, the study also covers eXplainable AI techniques, that can be used by experts in the field to interpret models and, overall, gather insights as well as enable trust.

References

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