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DEEP LEARNING TECHNIQUES APPLIED TO MONOCULAR CAMERA FOR DEPTH AND NORMAL MAPS ESTIMATION ON A LUNAR LANDING SCENARIO.

Abstract

Relative Navigation in a space context is a challenging task which implies perception, navigation, guidance and control capabilities in order to successfully achieve a mission. In such context, small errors could result into complete mission failure. To overcome such issues, several works focused on a multiple sensors fusion scheme solution allowing far more robust relative navigation algorithms to benefit from sensors complementarity. However, it comes at a high computational cost in return while making it a more onerous and complex mission. The perspective of relying solely on a monocular camera sensor solution to tackle relative navigation in lunar landing scenario is appealing in this regards. Monocular visual odometry algorithms are known to be affected by scale ambiguity preventing accurate estimation of the distance between the lens and the scene content. This makes relevant features detection and tracking, necessary to calculate a lander's ego-motion, challenging at a far distance from the landing spot. This paper proposes to investigate a different approach to classical relative navigation algorithms by introducing a deep network architecture trained to estimate the depth and normal maps from a single image based on a lunar landing scenario. The proposed architecture in trained in a supervised end-to-end fashion and takes advantage of multi-tasks learning where the respective depth and normal maps objective functions reinforce each others providing an improved final estimation. The network is trained on data extracted from a lunar-like terrain procedurally generated using the Unreal Engine 4. This 3D environment contains hills, plateaus, rocks and craters of a very high resolution quality in comparison to existing tools. (e.g PANGU). This offers the possibility to create an infinity of diverse scenarios providing the network sufficient examples for generalisation and avoids overfitting.

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