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Author: Mr. Pedro Pinheiro
Spin.Works S.A., Portugal, pedro.pinheiro@spinworks.pt

Mr. João Oliveira
Spin.Works S.A., Portugal, joao.oliveira@spinworks.pt
Mr. Tiago Hormigo
Spin.Works, Portugal, tiago.hormigo@spinworks.pt
Mr. Francisco Câmara
Spin.Works S.A., Portugal, francisco.camara@spinworks.pt
Prof. Rodrigo Ventura
Institute for Systems and Robotics, Portugal, rodrigo.ventura@isr.tecnico.ulisboa.pt

VISION-BASED NAVIGATION SUPPORTED BY CONVOLUTIONAL NEURAL NETWORKS FOR LUNAR AND PLANETARY LANDING MISSIONS

Abstract

Vision-based navigation systems are a prominent technology in the space industry. This method is based on using camera images as the primary navigation system to estimate spacecraft relative position and attitude, namely for rendezvous and proximity operations, such as lunar or planetary landing missions. In the last few decades, conventional image processing techniques are being replaced by Convolutional Neural Networks in a vast number of tasks and domains, since these Artificial Intelligence methods are outperforming on most benchmarks. Inspired by these promising advances, in this Thesis, we investigate Deep Learning alternatives to classical image processing algorithms, which may be applicable to image-based navigation in the scope of planetary landing missions. Thus, we propose a complete framework to evaluate any image feature detector for the task of motion states estimation during a planetary landing mission, using both representative and simulation datasets, as well as the image sequence collected during the recent NASA Perseverance Rover landing. To accomplish this goal, a solution based on homography relation is designed. A qualitative and quantitative evaluation of the whole pipeline is presented, comparing both classical feature detectors and one based on Deep Learning architectures. From our promising results for applying machine learning to this problem, we introduce an alternative to classical Computer Vision algorithms. Furthermore, we discuss some possible future work to improve the results.