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SPACE SYSTEMS SYMPOSIUM (D1)
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Author: Mr. Marco Carpentiero
Sapienza University of Rome, Italy

Dr. Marco Sabatini
Università di Roma "La Sapienza", Italy
Prof. Giovanni B. Palmerini
Sapienza University of Rome, Italy

CAPABILITIES OF STEREO VISION SYSTEMS FOR FUTURE SPACE MISSIONS

Abstract

Future space missions are likely to exploit advanced computer vision systems, providing high accuracy and a rich and comprehensive perception of the scenario/environment. Till now, main tasks of computer vision has been the detection and recognition of objects of an already known shape: this approach was adopted in the automatic rendezvous, carried on by identifying specific markers in acquired images. Improvements in optical sensors' quality, software skills and computational power allow today to attempt a full reconstruction of the observed scene, and this new approach could greatly expand the applications of computer vision in space missions. In planetary surface exploration rovers will have a clear benefit in observing the global scenario allowing safe path planning thanks to an increased capability in identifying obstacles and their relevant risks. In a different frame, computer vision will also be extremely helpful in orbital robotic operations, where the full scene reconstruction is crucial in carrying on the grasping and manipulation of non-cooperative targets, as in the currently hot topic of debris removal.

Stereo vision represents the cornerstone of these advanced techniques. Binocular or even multiple points of view enable a full 3D representation of the scenario, providing the information about distance missing from a pinhole representation. Specific algorithms are obviously needed to combine the different images, matching up extracted features.

The main purpose of this paper is to present some results on robustness and autonomy of stereo vision systems, taking computation and hardware requirements into account. To this aim the paper will initially show the algorithms used for stereo image analysis and then will explain the criterion to identify obstacles, to establish their location in the workspace and assign them a "risk index". The final goal will be to draw a virtual map of the workspace reporting the position of the obstacles and their "region of influence", depending on the relevant risk index. This map will be used to plan a safe path for the motion of a rover or a robotic arms, making use of guidance laws designed to take into account obstacle avoidance. In addition to numerical simulations, preliminary experimental results will be also presented, with specific reference to the case of the rover RAGNO (standing for Rover for Autonomous Guidance Navigation and Observation) available at the Guidance and Navigation laboratory of the University of Rome La Sapienza.