Terrain Aided Navigation for Planetary Exploration Missions

Authors:
Jakob Schwendner
DFKI Bremen
Robotics Innovation Center (RIC)
Robert-Hooke-Straße 5
28359 Bremen, Germany
Phone: +49 (0)421 17845-4120
E-Mail: jakob.schwendner@dfki.de

Submission for oral presentation.

Abstract:
Mobile robotic systems will without a doubt become even more relevant for space exploration missions than they currently are. High cost for manned programs and recent success of robotic mission (e.g. MER) are likely to form a shift towards robotic missions. One of the key aspects of exploration systems is mobility. Apart from the physical capabilities to negotiate complex and difficult terrain, the aspect of navigation is also of great importance. Global Positioning Systems like the GPS are not available outside of earthbound activities. The previous successful approaches for mobile robot navigation in space are vision based. A great number of positive sides like environmental awareness and exploitation of the images for science are on the up-side of this. There are however some design constraints in order to make the use feasible. Image processing does require a certain amount of processing resources and a favorable positioning of the cameras. One possible alternative could be the use of Terrain Aided Navigation methods for vision free localization in known environments. By using a-priori information about the environment (e.g. from orbiter sensor or other sources) the information on the orientation and the position of the environment contact points can be used to estimate the position of the robot within the map [1]. The feasibility of the this approach is demonstrated using Digital Elevation Maps from the LRO LOLA Instrument and a simulated mobile robot based on the Asguard [2] system. We employ a Bayesian filtering method to estimate the position of the robot within the map, and compare it to the position from the odometry. We also investigate the effect of the resolution of the a-priori map on the final localization error. While the proposed method should not be seen as a complete replacement of visual navigation, it can augment such systems. It can also provide a localization solution with a bounded error for missions where visual processing is not feasible due to resource or engineering constraints.

[1] Schwendner J, Joyeux S. Self Localisation using Embodied Data for a Hybrid Leg-Wheel Robot. In: *IEEE International Conference on Robotics and Biomimetics*.; 2011.

[2] Joyeux S, Schwendner J, Kirchner F, et al. Intelligent Mobility - Autonomous Outdoor Robotics at the DFKI. *KI - Künstliche Intelligenz*. 2011.