SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration - Part 2 (3B)

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VIRTUAL MARS SIMULATOR FOR ROVER AUTONOMY VALIDATION AND TESTING

Abstract

The paper presents a tool developed to provide a general purpose testbed to validate the design, to simulate and settle surface operations, to check for on-board autonomy performances within the wide field of planetary surface exploration missions. More specifically, attention is here focused on planetary rovers, a significant element of current and incoming space missions. To this end the developed simulation tool is made up of different sets of components to be activated and tailored according to the scenario to be analyzed and the tests to be run. The rover kinematics simulator, for instance, may be adequate to test high level autonomy skills such as those related to the on board path-planning; on the other hand, the rover dynamics simulation module – which includes the soil-wheel interaction evaluation – may be exploited to test for the selected set of actuators and implemented control law to assure the vehicle mobility. The tool, currently based on the ExoMars planetary rover as a default scenario, is made of a simulation module and a virtual reality interface. In particular the virtual reality is exploited to generate commands sequencing, to check for the navigation and locomotion systems, and to visualize the results. The simulation module includes: a user defined rover configuration; a navigation module – based on a potential field techniques for obstacles avoidance – to let the vehicle safely move into the virtual environment created for the mission currently under study; the multi-body model of the rover nested in the simulation environment, including a traction control of the wheels and a wheel-soil interaction model; an artificial vision system to get a detailed reconstruction of the environment, the path-planner leans on to identify a safe path. The virtual environment contains all physical properties of the Mars surface: information about past missions are considered to model the rock distribution and the soil parameters; the tool exploits those inputs to build a soil map, that it is used by the navigation module to solve the path-planning problem. The rover simulator is a dynamic and complex project, but it is fundamental to get rid of a planetary surface vehicle robust design to successfully cope with uncertainties intrinsic with the space environment. More those uncertainties may give rise to unpredictable events only manageable through an enhanced on board autonomy a simulator helps to validate.