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Author: Mr. Riccardo Lombardi
Politecnico di Milano, Italy, rickylomb@alice.it

Mr. Pietro Francesconi
Politecnico di Milano, Italy, pfrancesconi@aero.polimi.it
Prof. Michèle Lavagna
Politecnico di Milano, Italy, michelle.lavagna@polimi.it

3D VIRTUAL PLATFORM TO VALIDATE PLANETARY VEHICLES DESIGN AND OPERATIONS

Abstract

In the deployment of planetary exploration vehicles the autonomy level requirements represent an hot spot: which functionalities to refer to autonomous mechanisms, where to locate autonomous high level reasoning - either on board or on ground - are some of the trade-off to solve. A key role is covered by the vision sensors those vehicles are typically equipped with to answer the environment knowledge requirements both for surface mobility and landing accuracy and safety (autonomous and timely obstacle identification and avoidance, path planning and navigation control and scientific goals achievement). The virtual 3D environment simulation included in the presented tool, is supported by faithful representation of the real physics of the dynamic phenomena related to rover locomotion and EDL vehicle trajectories including vehicles' subsystems response to environment conditions and cross-dependencies. More in details, the environment is user-defined to support different mission scenarios and planets to simulate both vehicle responses and planned activities; as a consequence, design choices both at subsystem and system level can be cross checked in terms of effectiveness, robustness and flexibility of the vehicle. The synthetic environment representation is also exploited to generate the visual sensors inputs, first element in the position, attitude and velocity determination for either autonomous or supported navigation purposes. Customisable options include type and properties of soil, surface geometry and atmosphere as well as their dependencies from time (daily and seasonal variations). Subsystems have been divided into generic (i.e. EPS and Thermal control) and vehicle-dedicated; the formers have a shared interface and are based on a common structure thus allowing to define the subsystems as a combination of their components. Dedicated subsystems (i.e. rover's path planning and locomotion, ADCS and RCS for landers) can be defined and modified as a function of the mission scenario. In both cases substitutions or refinements without major changes on existing interdependencies among on-board subsystems are possible. The simulator includes general use open-source libraries (Irrlicht, ODE and GSL for rendering, physics calculation and mathematical functions respectively) and is based on C/C++ languages. All the mentioned elements allow the user exploiting the tool to test vision based algorithms for both environment reconstruction and navigation, autonomous planners/schedulers for surface operations, environment effects on the design adopted solutions. The tool architecture and software design together with examples which highlight the flexibility of the proposed tool in terms of settable I/O are presented and discussed in the paper.