Modelling and animation of virtual autonomous mobile robots, in physically simulated world, for the evaluation of locomotion and navigation structures

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Abstract

A mobile robot is the most suited element to transport scientific instruments to diverse scientifically interesting sites on extraterrestrial planets. Instruments to examine geology, mineralogy or exobiology can be easily deployed. Since the Mars Pathfinder mission, new missions for in-situ planetary exploration demand for increased mobility on planetary surfaces.

The realization of robots dedicated to planet exploration require a number of abilities, such as obstacle avoidance, overcoming of obstacles, displacement of objects using end-effectors or visual recognition which in most cases are relatively expensive to achieve. Moreover, it is sometimes difficult, or even impossible, to predict the behaviour and to assess in situ the effectiveness of robots designed to carry out tasks in environments hostile to man. It is the case, for example, of autonomous mobile robots designed to explore extraterrestrial sites. To solve these problems, software environments allowing to model and to simulate a physically robotized system have recently emerged. These software tools have the advantage to allow the assessment in virtual context, of the physical properties, for a cost lower than in real world, of various architectures for robotized systems such as mobile autonomous robot.

Among the various software environment for the simulation of autonomous mobile robots, one can mention the software Webots. With this software, autonomous mobile robots having the same structure than those intended to participate to the Swiss and European robotics contest have been modelled and then simulated physically in order to evaluate their capabilities to move and avoid obstacles. Structures of more complex autonomous mobile robots, like those used in planetary exploration have also been modelled, with an aim of contributing to the evaluation and the comparison of their effectiveness to cross obstacles. Such robots are designed for any type of ground ("Rovers"). It is thus necessary to consider various architectures and various locomotion parameters, in a variety of environmental conditions.

The main components of the modeller include static objects, and, more specifically, mobile structural elements such as joints and servodrives, with predefined torque and force features, friction and elasticity attributes. The modelling of closed-loop kinematic structures, while not functionally impossible, is relatively difficult to achieve. Nevertheless, current solutions show that the global behaviour of complex kinematic structures, such as rovers with 12 joints, can be effectively handled, allowing for interesting conclusions in terms of performance and relative merits of alternative architectural choices. A further attractive goal would be to use such an environment in order to tune-up and optimize architectural parameters, such as centroid location or wheel radius.