A framework for robotic rovers' navigation and obstacle avoidance

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Abstract

Keywords: *reactive/deliberative architecture, mobile holonomic robot, anticipated perception.* In this paper, a deliberative/reactive robotic architecture for spatial exploration in an unstructured, unknown and hostile environment is proposed. The robot is mobile and holonomic, and it is equipped with a camera able to monitoring its environment. Moreover, the robot has a shield enabling it to defend itself from small objects falling on its path. The robot government system is formed by two independent modules working in a parallel, asynchronous way: a deliberative and a reactive one. The perceptive data constitute the input for both modules, which process them with different frequencies. As a first step, the robot plans its best trajectory for a specific assigned task (deliberation). The main purpose of the reactive module is to preserve the robot structure: by exploiting data coming from a camera and other sensors, with parameters supplied by the deliberative module, the nearby environment is watched (with special attention to the possible collision with falling objects). An anticipated perception system in the deliberative module is able to compute a not exact evaluation of the impact energy of an object potentially hitting the robot, basing the computation on the form and velocity of moving objects detected by the sensors, using updatable parameters for the inferences. By computing the time interval between an object's detection and its estimated impact with the robot, the system is able to decide if (cfr. Figure 1):

- satisfy this obstacle's avoidance as a secondary task in its inverse kinematics scheme with functional redundancy, if enough time is available to execute its primary task (e.g. to pick up some sample from an unknown planet);
- compute a new trajectory (the deliberative module plans a new optimal path) in order to avoid the impact and to decide to drop its primary task, if it is no more compatible with the eventual impact of dangerous objects;
- activate the reactive module (with parameters established by the deliberative module) taking into account the possibility of impact with other obstacles on the ground, as follows; if there isn't enough time to plan a new trajectory, the reactive module manages the following robot's behaviours:
    1. don't care: if it predicts that the impact energy computed is under a certain threshold. It means that the robot has to go on on its planned path;
    2. protect yourself with the shield and go on: if it predicts that the impact energy has a range between a minimal and a low threshold. It means that the robot has to turn and protect itself with the shield. If possible, it has to stop in order to guarantee an optimal equilibrium;
    3. escape: if the impact energy is estimated great enough to potentially damage the robot structure. It means that the robot has to run away from its actual position with a certain velocity, being careful to avoid obstacles.

After each impact, the robot reactive module matches the energy impact estimated with the one computed from its sensors. This information is sent to the deliberative module, enabling it to construct a set of cognitive evaluations about the falling objects and, if necessary, to update its parameters' inference system.

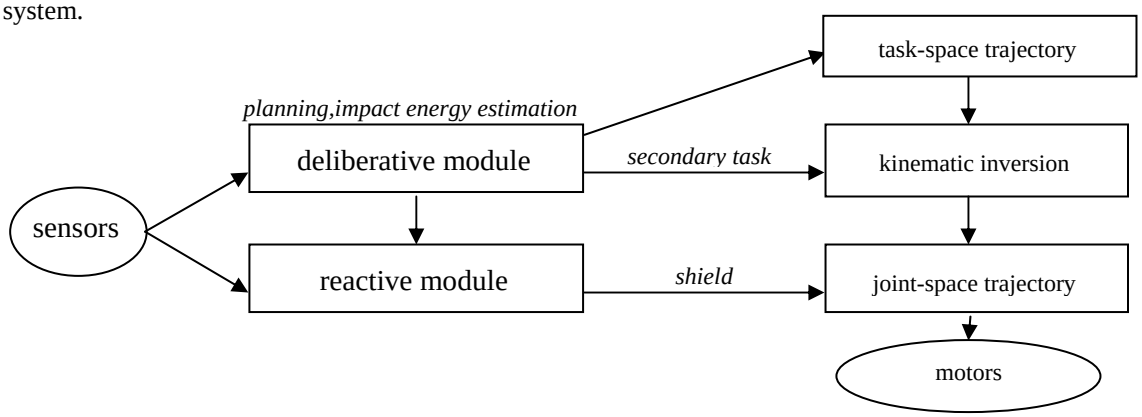

Figure 1. System's architecture