Autonomous Robot Exploration of Unknown Terrain: A Preliminary Model of Mars Rover Robot

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Much work in the field of autonomous mobile robotics has been done, for example through evolutionary robotics (Nolfi & Floreano 2000). These studies are often based on a simple robot, such as Khepera, and have been tested for navigation and obstacle avoidance in plain terrains. One potential area of application of autonomous mobile robotics is in the field of interplanetary exploration. For example, the Rovers Spirit and Opportunity robots currently exploring Martian surface are capable of autonomous navigation with hazard avoidance utilising stereo cameras. However, there is no other way for the rover to avoid obstacles in case of the cameras failure. Navigation based on infrared sensors could be used as a possible back-up solution in case of such failure.

We present a new simulation model of the Rover Mars robot based on infrared sensors. This work has the objective to investigate the possibility of using an alternative (back-up) obstacle avoidance system for future rovers capable of performing autonomous tasks in challenging planetary terrain environments. The 3D simulation model of the robot and of Mars terrain is based on the physics engine Open Dynamics Engine. The robot model has forty sensors attached at three different height levels to allow detection of small and high obstacles as well as steep slopes and holes that are over 30cm. The robot control system consists of an artificial neural network trained using evolutionary computation techniques. The model has been tested in various terrain configuration and variable sensor configuration. Simulations results show that the robot is able to learn to avoid rocks, holes and steep slopes purely based on the infrared sensory inputs. As the controller is based on a neural network, this allows it to have good performance even in presence of increased noise.