Carnegie Mellon University
Computer Science Department

Speaking Skills Talk

Active Perception and Exploration in 3D-rich Planetary Environments

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Some of the most compelling targets for future science and exploration in our solar system lie in terrain that is inaccessible by state-of-art robots. The presence of water has been confirmed on Martian recurring slope lineae, but these RSLs are located on steep walls and escarpments that are beyond reach of traditional rovers. Dramatic ridges, cracks, craters, crevasses and spires await on icy moons, but these defy existing robot technology. Pits on Mars and the Moon are similarly enticing and challenging. Planetary drones hold the prospect to fly where others cannot roll or climb. Beyond the physical form of mobility, essential innovations include the enabling autonomy required to make these new forms of exploration possible.

This talk will present an active perception and exploration framework that enables planetary robots to efficiently explore rich, significantly 3D environments including pits, caves, RSL, and geysers. The approach seeks to achieve real-time operation on computationally constrained systems while ensuring energy efficient information acquisition. The trajectory generation formulation is based on state-lattice motion primitives and evaluation of the Cauchy-Schwarz Quadratic Mutual Information at each lattice state. Trajectories are selected by maximizing a measure of information gain per expected execution cost (e.g., time or energy). An extension to the exploration framework that considers multi-modal sensing and mapping will also be presented.

Presented in Partial Fulfillment of the CSD Speaking Skills Requirement.