AI for Autonomy in Space Exploration: Current Capabilities and Future Challenges

Robert Morris
NASA Ames Research Center, USA
Email: morris@email.arc.nasa.gov

To accomplish the next generation of challenging missions to the Moon, Mars, and beyond, researchers at NASA centers and at academic institutions have made significant progress over the last five years towards developing autonomous systems that can make critical decisions independently of human operators. Autonomy technology will extend the boundary on what can be accomplished in future missions by overcoming limitations due to communications delays, light-speed constraints, mission complexity, and cost. Autonomous systems will enable future space missions by maintaining vehicle health and safety, accomplishing complex science and mission goals, and adapting to changing circumstances or opportunities.

This talk will provide an overview of the current state of autonomy technology applied to deep space exploration, with particular emphasis placed on robotic surface explorers. First, I will motivate and describe the notion of autonomy as an enabler for deep space exploration. Second, I will discuss the contribution of Artificial Intelligence in current autonomy architectures, illustrating how automated systems for planning, plan execution and health management are being integrated into traditional control systems. Third, I will illustrate the challenges for developing autonomous systems through a case study of involving a Mars scenario, in which a rover is required to traverse to a target of interest, extend a flexible arm and acquire a close-up image. The ability to perform this scenario autonomously required advances along a broad technological front, including technology related to target tracking and instrument placement, planning and execution, and automated ground tools for coordinating with science teams. Finally, I will discuss the future challenges in developing autonomy technology for realizing NASA?s goal for humans to return to the Moon and eventually establish a permanent presence on Mars.