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Moon Exploration – Part 2 (2B)

Author: Dr. Matthew Sorgenfrei
National Aeronautics and Space Administration (NASA), Ames Research Center / SGT Inc., United States

ON THE DEVELOPMENT OF LUNAR ROVER MOBILITY SIMULATIONS FOR THE RESOURCE PROSPECTOR MISSION

Abstract

Recent robotic exploration of the Moon has revealed an abundance of resources at or near the surface that could support future human exploration. Prior to the design of any human mission, it will be necessary to better characterize the nature and distribution of such resources through robotic precursor missions. However, autonomous rover operations on the lunar surface are complex: the distribution of rocks and other obstacles is poorly characterized, the soil can be quite soft, and the differences in lighting conditions that will be encountered during operations are stark. These characteristics make mobility operations particularly challenging, and it is critical to develop robust simulators to study both the dynamic behavior of the rover and the lunar environment that is perceived by operators on Earth. This paper will describe a suite of tools to enable lunar rover operations currently under development at NASA Ames Research Center, with specific application to the upcoming Resource Prospector mission. Scheduled for launch in the early 2020s, Resource Prospector will search for hydrogen, oxygen, and water in craters of the polar region of the Moon. Two aspects of the Resource Prospector simulation suite will be discussed herein: the basic dynamic/kinematic model developed in MATLAB and Simulink, and a rover driving simulation created in the Robot Operating System (ROS) environment. The MATLAB/Simulink simulation is responsible for modeling all aspects of the rover itself, including steering and driving dynamics, sensor fusion, and closed-loop control. The ROS driving simulation addresses motion across the lunar surface, challenges induced by disparate lighting conditions, and localization and hazard detection using visible light cameras. Current simulation results using both development environments will be presented herein, and in certain cases comparisons will be made to hardware results collected using a prototype rover housed at Johnson Space Center. The Resource Prospector mission is in the early formulation stage, and consequently a number of studies are being undertaken regarding driving and steering approaches and styles. This paper will examine rover locomotion using both four wheel, fully-articulated motion, and the simpler differential drive or "skid steer" approach. The paper will conclude with a discussion of the approach the project will take to developing the final flight software, in which MATLAB/Simulink elements will be auto-coded into flight software applications that can then be integrated into the Core Flight Executive/Core Flight Software (cFE/cFS) flight software architecture.