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ASSESSMENT OF ROBOTIC RECON FOR HUMAN EXPLORATION OF THE MOON

Abstract

The human return to the Moon in 2020 offers new opportunities to advance the scientific exploration of the lunar surface. But, when the new exploration campaign begins, humans will initially be on the Moon less than 10% of the time. During the rest of time, however, robots will be available to perform surface operations. A central challenge, therefore, is to understand how human and robotic activities can be coordinated to maximize scientific return. We believe that one way to do this is through robotic recon.

We define robotic recon as operating a planetary rover under ground, or non-EVA astronaut, control to scout planned sorties prior to EVA activity. Scouting is an essential phase of field work, particularly for geology. Robot instruments provide measurements of the surface and subsurface at resolutions and from viewpoints not achievable from orbit. This surface-level data can then be used to select locations for field work and prioritize targets to improve crew productivity. Robotic recon can be done months in advance, or be part of a continuing planning process during human missions.

Since 2008, we have been developing and evaluating systems, operational concepts and protocols for robotic recon. Our approach is inspired by the Mars Exploration Rovers (MER), as well as human spaceflight, including Apollo, the Space Shuttle, and the International Space Station. Our ground control, for example, integrates a science team similar to the MER Science Operations Working Group and the Apollo "Science Backroom".

We believe that robotic recon improves human exploration in three ways: (1) it increases scientific understanding so that better traverse plans can be produced; (2) it reduces operational risk by evaluating routes and terrain hazards; and (3) it improves crew productivity by enabling detailed activity planning. To quantify these improvements, we recently conducted a field experiment of robotic recon at Black Point Lava Flow (New Mexico).

In our experiment, a team at NASA Ames teleoperated a planetary rover equipped with cameras (panoramic and microscopic imagers) and 3D scanning lidar to scout routes and sites. The recon data was then used to plan geology field work, which a two-man crew performed using the JSC "Lunar Electric Rover" and simulated EVA suits. We then used a variety of metrics to assess the quantitative impact of robotic recon on planning, operations, and crew activity. This paper describes the detailed design of this experiment, presents our results and discusses directions for future research.