

Using RSVP for Analyzing State and Previous Activities for the Mars Exploration Rovers

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Current developments in immersive environments for mission planning include several tools which make up a system for performing and rehearsing missions. This system, known as the Rover Sequencing and Visualization Program (RSVP), includes tools for planning long range sorties for highly autonomous rovers, tools for planning operations with robotic arms, and advanced tools for visualizing telemetry from remote spacecraft and landers. One of the keys to successful planning of rover activities is knowing what the rover has accomplished to date and understanding the current rover state. This paper will discuss the tools and methodologies present in the RSVP suite for examining rover state, reviewing previous activities, visually comparing telemetered results to rehearsed results, and reviewing science and engineering imagery.

As rovers can range over greater distances with more autonomy when they have accurate self-locating systems, the operator paradigm shifts from a hands-on micromanagement level to a hands-off level of mission specification. This calls for a more immersive interaction with the environment with tools for designating waypoints, samples to be collected, regions of hazard and interest, and other types of features. Similarly, when examining rover activities and state, examining numeric values must be enhanced with immersive visualizations of rover activities and display of imagery and other science data collected.

The primary goal of the immersive analysis tools in RSVP is to provide the mission planners with the best possible understanding of the rover's state. To support this activity, several tools may be used, either separately or in concert. For reviewing state and histories of telemetered values, a graphical tool for plotting state values versus time is available with a variety of simple pan, zoom, and query methods implemented. This may be combined with the immersive visualization environment and a VCR-like control to animate a rover model in response to the telemetry data available. This tool can animate multiple models simultaneously, allowing visual comparison of telemetered results to the results of rehearsals performed during the mission planning phase. Understanding how well the rovers' behavior conforms to the predictions is crucial in safely planning future activities.

An additional tool allows the operators to display imagery from the cameras onboard the rovers. Imagery from the PanCams, NavCams, and HazCams can be displayed with annotation on camera pointing, allowing user's to review imagery for planning additional science observations. In addition, for mobility operations, selected imagery may be processed to produce specialized terrain models for review and planning of robotic arm activities or special movements.

The combination of these capabilities, integrated with the RSVP system tools for mission planning, provide the rover operators an optimal understanding of rover state as a prerequisite for safe, successful mission operations.