Simulation of Hazards and Poses for a Rocker-Bogie Rover

Vehicle poses and locations of hazards can be viewed before attempting traverses.

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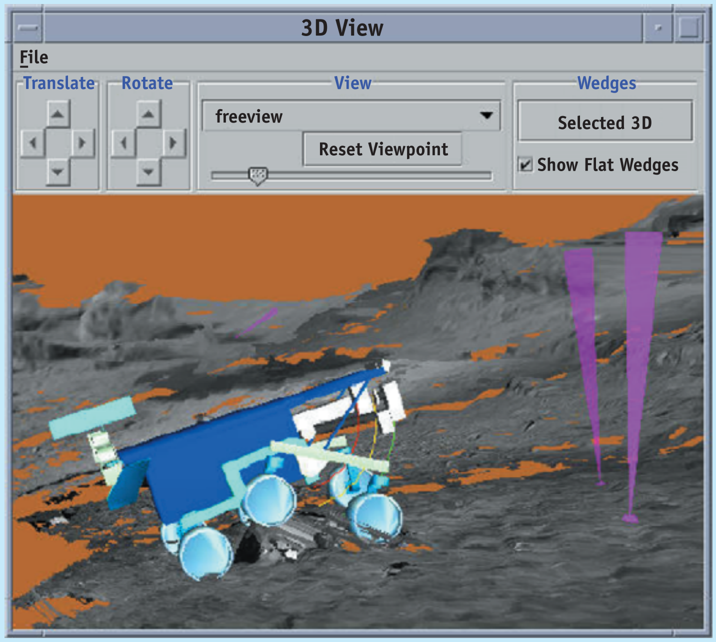
Provisions for specification of hazards faced by a robotic vehicle (rover) equipped with a rocker-bogie suspension, for prediction of collisions between the vehicle and the hazards, and for simulation of poses of the vehicle at selected positions on the terrain have been incorporated into software that simulates the movements of the vehicle on planned paths across the terrain. The software in question is that of the Web Interface for Telescience (WITS), selected aspects of which have been described in a number of prior *NASA Tech Briefs* articles. To recapitulate: The WITS is a system of computer software that enables scientists, located at geographically dispersed computer terminals connected to the World Wide Web, to command instrumented robotic vehicles (rovers) during exploration of Mars and perhaps eventually of other planets. The WITS also has potential for adaptation to terrestrial use in telerobotics and other applications that involve computer-based remote monitoring, supervision, control, and planning.



This **Computer-Generated Image** is typical of the images generated in simulations of the articulation of the rocker bogies and the tilt of the main body of the rover as it traverses terrain.

The hazard-specification provision enables a user to interactively specify hazards in terms of zones on the terrain. On an interactive computer display that contains an overhead view synthesized from previously acquired images of the terrain, the user specifies the horizontal location of the center of a hazard zone. Then, using a display denoted a hazard window, the user specifies the height of the center of the hazard zone and the horizontal radius of the hazard zone. The user can also add a textual comment about the hazard. Once the hazard zone has been thus specified, it is depicted as a yellow circle on WITS synthetic views of the terrain.

The collision-prediction provision enables a user to see where the planned rover path could cause the rover to collide with a specified hazard. The traversal of the terrain by the rover is specified by designating way points, and the planned path becomes a sequence of straight-line (as viewed from overhead) segments between the way points. At small increments of position along the planned path, the distance from the rover to all the specified hazard zones is computed. The difference between each such distance and the radius of the hazard zone is computed and compared with two previously specified distances: one denoted the safe distance and a smaller one denoted the collision distance. If the computed difference distance exceeds the safe distance, then there is assumed to be no risk of collision and the affected segment of the path is shown green on the WITS synthetic terrain images. If the computed difference distance lies between the safety and collision distances, the affected path segment is deemed to be risky and is shown yellow on the terrain images. If the computed difference distance is less than the collision distance, the affected path segment is designated as a collision segment and is displayed in red.

The pose-simulation provision is, more specifically, a provision for simulating the articulation of the rocker-bogie portions of the suspension and the tilt of the main body of the vehicle, given the equivalent of a topographical map of the local terrain with which the vehicle is in contact (see figure). This provision enables the user to view the changing rover bogie angles as the rover travels its planned path across the terrain. For each increment of position along the path, the horizontal positions of the six rover wheels are computed approximately under the assumption that the rover tilt angles are small. Then the elevations of the wheels are computed by use of the estimated horizontal wheel coordinates and the topographical information. Then the bogey angles and the tilt angles of the main body are determined from the elevations of the wheels and the known geometric relationships among the wheels, the bogies, and the main body.

This work was done by Paul Backes, Jeffrey Norris, and Mark Powell of Caltech and Gregory Tharp of IA Tech, Inc., for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
NPO-30450