FIDO: A Field Integrated Design & Operations Rover for Mars Surface Exploration

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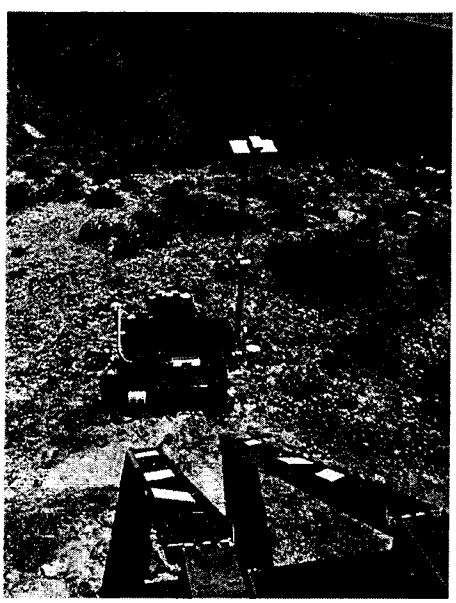

We overview the development and terrestrial field testing of a new vehicle for long ranging semi-autonomous Mars science exploration and sample return. By contrast and comparison to NASA's Mars Pathfinder Sojourner flight experiment of 1997, which restricted rover operations with a single science onboard instrument to a 50-100 meter surround of the lander, the Field Integrated Design & Operations (FIDO) rover is a new highly instrumented advanced technology prototype for semi-continuous science exploration up to several kilometers beyond a landed horizon, under minimal ground intervention. FIDO rover, an approximate 0.8x0.5x1.0 m^3 70Kg vehicle now in operation at the Jet Propulsion Laboratory, is the conceptual basis for an upcoming NASA Mars '03 mission. In its most general operations theater, FIDO can proceed away from its landing site under semi-autonomous sensor-based control into diverse terrain, following a path designated by ground scientists (as derived from orbital-descent-and/or-landed imagery), avoiding local obstacles, utilizing a rich on-board suite of science instrumentation to thematically target, mineralogically assay, closely observe, and physically sample rocks and soils of interest (ultimately coring and caching samples for autonomously guided return to an awaiting earth return vehicle/containment). To this end, FIDO rover carries a 2.0 meter science mast with high-resolution multi-spectral filtered pan/tilt stereo cameras, co-linear stereo panoramic navigation mapping cameras, a bore-sited near IR spectrometer, a 0.7 m dexterous sampling arm with attached micro-camera and Moessbauer spectrometer head, and mini-coring rock sampler. Rover control is remote and supervisory by means of a distributed Internet science/planning toolset, the JPL-developed Web Interface for Telescience (*WITS*). Building on technology contributions from a number of earlier NASA robotics tasks, such as Long Range Science Rover (*Rocky7*), Sample Return Rover (*SRR*), and Planetary Dexterous Manipulators (*MarsArm*/NASA Mars'98 mission) FIDO implements a variety of real-time stereo sensing, 3D mapping-localization, onboard fused navigational guidance (including celestial reference via calibrated sun sensor), visual-servoed manipulation and instrument placement, and visual recognition & terminal rendezvous functions with high precision and reliability. FIDO is currently being used by the NASA Mars'03 flight science team for simulations of upcoming mission scenarios. We report on such full scale science/engineering field trials, including a recent multi-week "blind" field test wherein a science team sequestered at JPL--lacking prior knowledge of a remote high desert operations site in Nevada--carried out the exploration and categorization of areal geology in a realistic mission flow via satellite up- linked commands and data product down-links and visualization. Collaborations have also included cooperative technology trials with colleagues at CNES (Toulouse, France), and an international program of educational outreach enabling student participation from home sites via the above noted WITS interface for distributed collaborative tele-robotic operations. We will overview this work, illustrating some aspects of the field trials with video recordings.

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Author Biography

Dr. Paul S. Schenker is Supervisor, Mechanical and Robotics Technologies Group, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, wherein he leads R&D in the areas of surface robotic mobility, sampling and advanced actuation. His current research focuses on development of autonomous rover based science and sample return, including new concepts in multiple rover cooperation and reconfigurable mobile systems for all terrain exploration. Recent examples include JPL's FIDO rover, Sample Return Rover, MarsArm (Mars Polar Lander R&D prototype), and Robot Assisted Microsurgery System. His research specializations include machine perception, sensor fusion, advanced robotic control, and intelligent user interfaces, in which he has authored about 100 peer reviewed publications. Dr. Schenker is a Fellow and the Immediate Past President of SPIE (1999).