National Aeronautics and Space Administration

NASA**facts**

Space Technology
Game Changing Development
Human Robotic Systems: Rover Technologies

Overview

The Rover Technologies element of the Human Robotic Systems (HRS) project primarily focuses on development and advancement of rover technologies for infusion into future extraterrestrial NASA surface missions.

Resource Prospector

Currently, the primary mission infusion target is NASA's Human Exploration and Operations Mission Directorate (HEOMD) Advanced Exploration Systems (AES) Resource Prospector (RP) mission.

Resource Prospector is a mission, currently planned to fly in 2022, to demonstrate prospecting and processing volatiles from lunar regolith (the layer of pulverized rock and other materials that covers the lunar surface). The mission is the next step in identifying volatile distribution for in situ resource utilization (ISRU) after prior lunar probes indicated water ice is trapped in permanently shadowed craters near the lunar poles.

The choice of destination includes identifying the distribution of volatiles in permanently shadowed regions and at varying depths up to 1-m deep outside shadowed regions. The lunar poles provide challenges to rover designs including (1) a need for improved navigation capability for a rover to operate in and sense soft soils and other hazards in low-light or dark conditions; (2) improved avionics and motor control to enable communication with and control of a remote rover and its tools over significant time delays up to 30 seconds; and (3) operating in the soft soils in very cold temperatures.

Rover Technology Development

In response to the mission goals and technology requirements of the RP mission, HRS is leveraging existing HRS and Space Technology Mission Directorate (STMD) robotics investments, adapting them for the RP mission requirements and increasing their technology readiness levels (TRLs) to 6, or demonstration in a relevant ground or space environment.

Resource Prospector Prototype

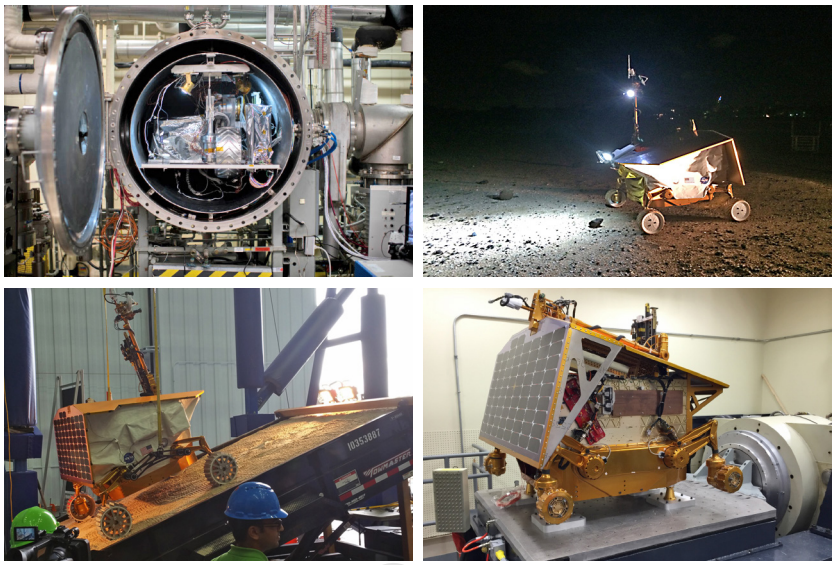
In FY15, HRS developed a full-scale rover prototype to use as a platform to develop and test the key rover technologies. The prototype rover has four wheel modules, each with independent electrical propulsion, steering and active suspension (think four-wheel drive with four-wheel steering, 4x4x4). These features assist in operation on soft soil, providing the ability to crawl or swim when the wheels are no longer able to provide traction. Additionally, the rover is able to drive in any direction (called crabbing) while keeping its solar arrays pointed toward the sun (when available) for optimal recharging of its batteries.

Prototype rover.

ARCHIVED

Other technologies that have been developed and continue to be tested and improved include:

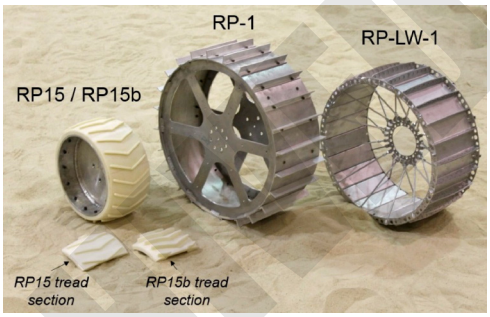
- Motor control and avionics capable of driving rovers and controlling rover tools over the Earth-Moon time delay.
- Advanced navigation software for rover's operation in high-contrast lighting and in the dark, with low on-rover computation resources.
- Advanced ground software systems that support rover exploration at a high pace under moderate time delays (1 week mission duration, with ~30 second time delay).
- Wheel and grouser design and optimization.



Rover environmental testing.

The prototype rover was required to operate under Earth's 1G gravity, but was designed as closely as practical to the actual flight vehicle.

During FY16-FY17, the prototype rover was utilized for functional testing with integrated ISRU payloads and for testing in rock-yards, gravity offloaded conditions and environmental test chambers.



2015 and 2016 RP wheel prototypes.

Second generation RP spoke wheel prototype, 2017.

In FY16, the primary focus was TRL advancement through environmental and field testing. HRS conducted integrated field tests with the rover at NASA's Johnson Space Center in Houston, Texas, while being commanded from NASA's Ames Research Center in Mountain View, Calif. This action served as a forcing function for software integration on the rover, engaged the RP mission operations team early in the development cycle, and served as a baseline evaluation of progress.

In FY17, the primary focus is design, test, and optimization of wheel design, updating the mobility system for lunar gravity, developing stereo localization in the harsh lunar polar lighting conditions, and experimenting with driving tools under moderate time delays.

Partnerships

Human Robotic Systems is led by Johnson, with support across multiple centers. HRS resides within the Game Changing Development (GCD) Program. HRS is partnered with the AES Resource Prospector mission.

Projects under GCD investigate ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about HRS please visit http://www.nasa.gov/directorates/spacetech/game_changing_development/human-robotic-systems.html (public)

For more information about GCD, please visit http://gameon.nasa.gov/

Point of Contact:
Bill Bluethmann / NASA Johnson Space Center
William.J.Bluethmann@nasa.gov

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

www.nasa.gov

FS-2017-10-290-LaRC