DDF annual report

**Title of Investigation:**

Goddard exploration Testbed for Information Technology (GetIT)

**Principal Investigator:**

David Matusow (Code 588)

**Other In-house Members of Team:**

David Hardison and Jeff Hosler (Code 588)

**Other External Collaborators:**

Illah Nourbakhsh (Carnegie Mellon University)

**Initiation Year:**

FY 2004

**Aggregate Amount of Funding Authorized in FY 2004 and Earlier Years:**

$20,000

**Funding Authorized for FY 2005:**

$30,000

**Actual or Expected Expenditure of FY 2005 Funding:**

$30,000

**Status of Investigation at End of FY 2005:**

Completed in FY 2005

**Purpose of Investigation:**

This project has three main goals:

To develop a simulated lunar or Martian landscape.

To use this landscape to develop core software expertise in robotic-control systems.

To make this resource available to researchers and educators.

**Accomplishments to Date:**

DDF funding has allowed the construction of the Multipurpose Exoterrain for Robotic Studies (MERS), a simulated Martian landscape that features variegated sand/rocks, dunes, eroded sedimentary scarp, alluvial washouts, volcanic remnants, and an impact crater (see Figure 1). It is located in the Building 23 courtyard.

**Figure 1.** A Personal Exploration Rover (PER) makes its way across the MERS terrain.

Two Personal Exploration Rovers (PERs) have been acquired through collaboration with Carnegie-Mellon University. Six all-terrain vehicles are currently being fabricated by Pacific-Gyre in California. These vehicles will be made available on an as-needed basis to researchers using MERS. In addition, a high-resolution radio-location system that can provide vehicle-tracking information for up to 10 targets has been installed.

Significant progress has been made towards demonstrating basic multi-platform collaboration, and initial work with MERS has been leveraging upon two major research projects within Code 580: the Adaptive Sensor Fleet (ASF) and Instrument Remote Control (IRC).

ASF is a software system for coordinated control of a fleet of autonomous ocean vessels being developed by Code 588 in partnership with the Wallops Flight Facility and NOAA. The software technology being developed is directly applicable to rovers and a current focus is adapting ASF for terrestrial-rover exploration activities at the MERS facility. IRC is a Java-based framework for distributed control of sensors and instruments. It is a project that has supported several missions, including SPIRE, SHARC II, SWAP II, HAWC, SAFIRE and COVIR. IRC is being used for rover control, and MERS is the first application for this framework.

Through discussions, Code 580 had with the National Institute of Standards and Technology (NIST) on the use of laser-ranging equipment for high-resolution topography scanning, we were able to get a sample LADAR (Laser Radar) surface scan performed on MERS (Figure 2).

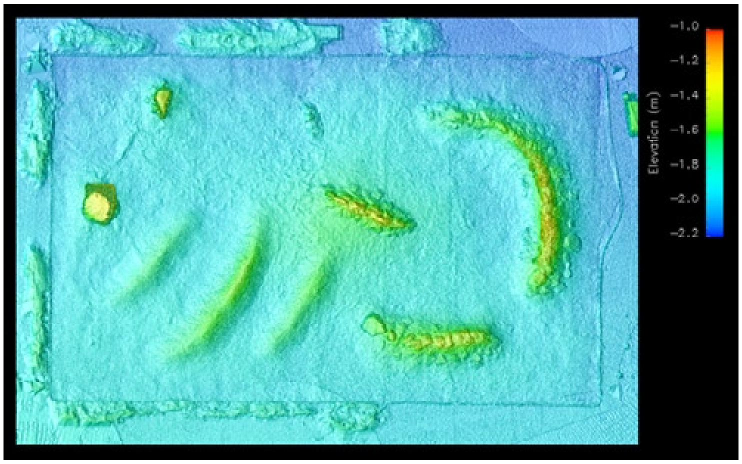


**Figure 2.** MERS elevation model produced by scanning LADAR camera

The data are similar to what would be produced by a laser-altimeter satellite, such as GLAS or MLA. The data will increase the fidelity of research into vehicle navigation.

MERS is generating a great deal of interest from external organizations and researchers. Code 600, Code 900, university researchers, and the "JASON" educational outreach program have all expressed interest.

MERS was a valuable asset for the first NASA Robotics Intern Program held during the summer of 2005. Several teams made extensive use of the terrain and a team working on vision-based target acquisition with the Personal Exploration Rovers tied for first-place in overall project excellence. The PER vehicles, which we acquired through this DDF, also have been incorporated into a course on Wireless Sensor Networks. Dr. Mohammed Younis at University of Maryland-Baltimore County (UMBC) taught the course in Fall 2005.

**Planned Future Work:**

A Core Capabilities proposal for FY 2006 was submitted by Code 588 to continue work with MERS and robotic fleet research. It was not funded. However, we expect to make proposal submissions for future funding opportunities. The facility is currently available for use by interested researchers and we expect it to be used during FY 2006 by students selected for the second summer Robotics Intern Program at Goddard. Dr. Younis also may use it.

**Key Points Summary:**

**Project's innovative features:** NASA's new Exploration Initiative indicates a strong need for advanced robotics. Robots must be able to function in unknown, unstructured, and dynamic environments. MERS provides a landscape to develop and test intelligent control strategies for heterogeneous groups of robotic vehicles operating on difficult terrains. It is Goddard's first such test environment .

**Potential payoff to Goddard/NASA:** MERS will encourage the development of advanced concepts for autonomous robotic systems and provide a reasonable test environment to assess the viability of these concepts as they relate to the Exploration Initiative. We will be able to use the testbed to do trade studies to determine which approach will work most efficiently and effectively. The facility will build core competencies in advanced engineering for multi-robot systems here at the Goddard Space Fight Center. It also will also build strategic partnerships with Carnegie Mellon University (CMU) and other leaders in the field of robotic research.

**Criteria for success:** The primary success criteria for MERS are how well it facilitates robotics research, both externally and within Code 580. Over past year, UMBC and several other external organizations have shown interest in using the facility. Internally, the Goddard Robotics Intern Program and Code 580's Adaptive Sensor Fleet project have used MERS.

**Technical risk factors that might have, or that in fact have, prevented achieving success:** The development of MERS provided several challenges that we have largely addressed. Initial work with the composition of the terrain resulted in a surface too soft for the PER vehicles to traverse. Experimentation resulted in a modified construction approach that provided a firmer surface for the rovers. It also is more tolerant to inclement weather and erosion. During initial project planning, we were unclear about radio-location or vehicle-tracking options. Our discussions with NIST personnel provided valuable information on Ultra-Wideband (UWB) location systems. We were able to purchase and install one that is now operational. Finally, there have been numerous tradeoffs associated with the all-terrain capabilities, sensor compliments, and cost of the robotic vehicles purchased from CMU and Pacific Gyre. By balancing these factors, we will soon have a heterogeneous group of eight different vehicles that researchers can use in conjunction with robotic vehicles they already may have.