INFUSION
Innovations from the NASA CICT Program
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"Personal Rover" Inspires Youth to Explore

- **Low-cost mobile science rovers inspire youth to learn more about science and NASA**
- **Students can design and execute Mars-like missions in their own backyards**

In 2004, when NASA's two Mars Exploration Rovers reach the planet, young people in America will be enacting similar missions in their backyards. You can be sure they will watch the television closely to see if the Mars rovers encounter the same challenges they did with their own personal rovers.

"Personal Rover" is an educational project funded by CICT's Intelligent Systems (IS) Project to engage public interest in robotic technology and excite the next generation about the autonomous robotic exploration of planets.

"One of NASA's primary missions is to capture the imagination of today's youth and inspire them to explore the boundaries of their knowledge and imagination," says Robert Morris, manager of the IS Project's Automated Reasoning subproject. "Illah Nourbakhsh, associate professor of robotics at Carnegie Mellon University's Robotics Institute, has designed the 'Personal Rover' curriculum to help fulfill this mission," says Morris.

My Martian summer

"We developed a summer course at CMU's Robotics Institute to teach 35 teenagers, recruited by National Hispanic University, how to build their own rovers from scratch and program them for use in exploring an environment," says Professor Nourbakhsh. "They used an earlier version of the Personal Rover, based on a custom 'TrikeBot' design created by Thomas Hsiu, who built robots for the films *Anaconda* and *Free Willy 2*. The TrikeBots look like small tricycles, without the seat or handlebars, but with a vertical neck and a videocam as a head. The latest version of the rover has six wheels and can climb stairs by shifting its center of gravity to accommodate changes in terrain."

What makes the rover run?

The rover's on-board HP® iPAQ™ handheld computer provides wireless communications to the student's laptop computer, and provides the processing power for real-time color tracking (the rover's videocam can track colors in a specified range). The iPAQ is connected serially to the custom-built videocam (CMUcam) and two BrainStem™ controllers (by Acroname)—one controls the main motor, and one controls the steering, the camera angle, the infrared sensor for range finding, and additional input/output. The two controllers relay data via an i2c bus to the serial multiplexer connected to the iPAQ, which manages the motors and sensors. The CMUcam's internal processor converts image data to numerical position data for the iPAQ. The rover's development environment runs on a laptop, with a Java interface for programming and controlling the rover.

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The PowerPuff Girls display the rover that completed their team's mission in twelve simulated Martian days.

Technology Spotlight

Technology

"Personal Rover"—a domestic, educational science rover

Function

Engage students in exploring the role of rovers in conducting remote science operations

Relevant Missions

- NASA Mission (part 3): "To inspire the next generation of explorers…as only NASA can."
- Mars Exploration Rover Mission (educational outreach)

Features

- Visual human-robot interface
- Motor, sensor, and videocam control
- Low-power, self-processing videocam—sends numerical location data
- Ability to climb up and down stairs, adjust to changing terrain
- Self-docking, scheduling, visual servo control, and other autonomy features

Benefits

- Provides hands-on experience with rovers of type used in NASA missions
- Uses low-cost components
- Supports community teaching
- Educates public about technologies enabling today's NASA missions—i.e., advanced autonomy

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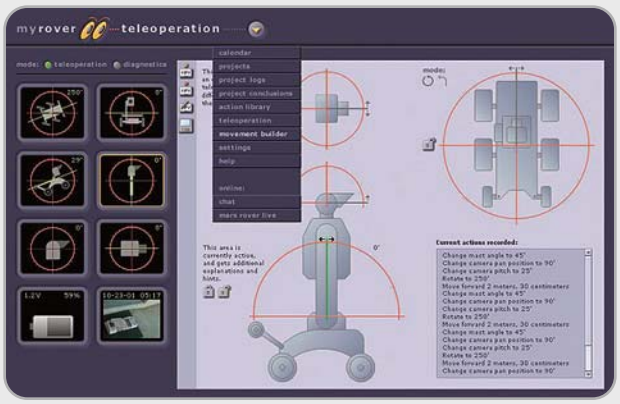
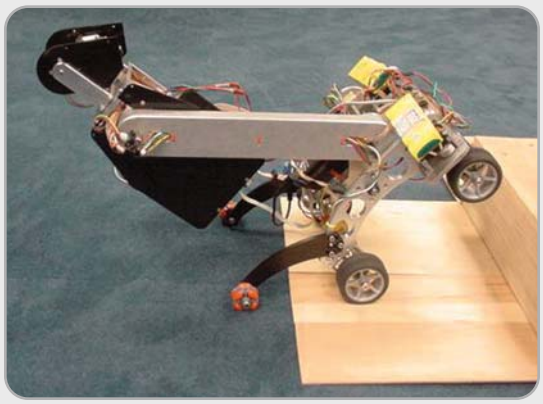


The Personal Rover can be operated remotely via its teleoperation interface (left).

Today's six-wheel rover (right) can even climb stairs!



The rover does many things on its own
The Personal Rover differs from many toy robots in its ability to be programmed and its autonomy. The rover's autonomy features include its ability to detect obstacles and modify its path accordingly. Its visual servo control feature enables it to visually maintain a desired distance from an object as it moves around it. Its scheduling feature enables the students to program rover missions to run at any time, whether they are present or not. The rover can autonomously integrate its execution of these scheduled tasks with other activities. When it completes its tasks, it can dock itself. Finally, a key feature of autonomy is knowing when to ask for help. The rover knows when it's in trouble, and when to request aid.

Putting the rover through its paces
During the seven-week course, the students competed as teams, programming their rovers to meet unique challenges, and then published their programs as "open source" code on their team Web sites. After the course, they took home their rover and laptop, with instructions for further projects. Nourbakhsh continues to study their progress to analyze the course's impact and their interaction with their rovers.

Do the Robo-cha-cha
In the first two weeks, the students created a Java program to track time, and perform basic moves. Then each team selected one of their rovers to represent them in contests such as chase the flag, musical chairs, and others. Finally, they got down to what most teenagers love to do—they taught their rover to dance for 60 seconds.

Autonomously exploring alien planets
In the third and fourth weeks, the students programmed their rovers for autonomous exploring, using the rangefinder, speed sensors, and videocam to wander safely across an unknown landscape, snap a picture of an "alien," and return home without getting permanently lost in a blind "canyon."

If it looks like a duck
In the fifth week, the students visually marked one rover as Mother Duck and programmed the others to be her ducklings, using their videocams to follow Mom as she moved autonomously around the course. The students then had their rovers use color tracking to follow them on a slow jog. This challenge taught them which colors are easiest for a rover to track and what it will do when it loses its leader.

On a secret mission
In the sixth week, the young robonauts were charged with providing security against the notorious Orange Illah—a nefarious intruder who sneaks into the building, stealing objects as he moves closer and closer to the rover on watch. The rover that sounds the alarm fastest wins, with extra points for photographing the thief, but beware of false alarms!

In the final week, the students conducted a top secret mission, called the "Game," requiring that they "teleoperate" their rovers (drive them without seeing them).

Sharing the excitement of exploration
"Working with these robots, young people become very excited about science, engineering, and the NASA mission," says Nourbakhsh. "In addition to our summer courses, we have tentative agreements to feature the Personal Rover in interactive Mars exploration exhibits at the Smithsonian Air & Space Museum, the San Francisco Exploratorium, and the National Science Center during the actual Mars landings. These museums attract over 15 million visitors per year. The Personal Rover will also be exhibited at the Visitor Center at NASA Ames Research Center. We continue to recruit corporate sponsors for additional programs in schools across the country. Our goal is to share the excitement of space exploration and technology with as many young people as possible."

—Larry Laufenberg

For more information or stories online, see **www.cict.nasa.gov/infusion**

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