National Aeronautics and Space Administration

NASAfacts

Space Technology
Game Changing Development
Autonomous Systems Project

The Autonomous Systems project is developing software, sensors, and other technology to automate the operation of systems such as spacecraft, habitats, and propellant loading systems that will be needed for future NASA missions. The project is a part of the NASA Space Technology Mission Directorate's Game Changing Development Program.

The project is led by NASA's Ames Research Center at Moffett Field, CA.

Automation is the ability of a system to perform a function without human support. Autonomy is the ability of a vehicle (or other system) and its onboard systems, such as computers and crew, to perform functions without external support. Autonomous systems are capable of operating independently from external communication, commands or control (such as commands from mission control on Earth). Such systems can involve crew and software during normal and contingency operations.

Currently, a team of experts at NASA's Johnson Space Center (JSC) in Houston controls the International Space Station remotely. For future missions to distant destinations such as Mars, there will be speed-of-light communication delays of up to 22 minutes each way. These delays will require astronauts to make more decisions without the assistance of people on Earth, especially when responding to unexpected challenges or problems such as mechanical failures.

The Autonomous Systems project is developing technology to help the astronauts make these decisions, including integrated systems health management software and sensors to automatically detect and diagnose spacecraft or system failures, and software to automatically plan sequences of actions to accomplish mission goals.

The Autonomous Systems project includes two separate but complementary project elements: Habitat Automation and Autonomous Cryogenic Loading Operations (ACLO). In addition, it includes several formulation tasks to investigate avionics, sensors, software verification, and other technologies needed to support autonomous systems.

The Habitat Automation element is currently testing and demonstrating technologies it develops using the second generation—or "Gen-2"—Deep

The second-generation Deep Space Habitat in the Arizona desert.

Space Habitat (DSH) at JSC. The DSH is a full-scale prototype habitat used to conduct field tests with NASA astronauts and flight controllers.

The ACLO element focuses on automating cryogenic fuel loading operations. Currently, this process is very expensive and labor intensive. ACLO will test and demonstrate component technologies and autonomous cryogenic loading operations at the Cryogenic Test Bed Laboratory at NASA's Kennedy Space Center in Florida.

In September 2012, the Autonomous Systems team participated in the DSH Mission Operations Test at JSC. Throughout the 2-week test, software provided by the team ran 24 hours a day monitoring the DSH systems. The software included the Advanced Caution and Warning System (ACAWS), which automatically detects and diagnoses failures in the DSH power and communications systems. A new feature added to ACAWS in FY12 is called the Failure Consequence Assessment System (FCAS). After a failure has been detected and diagnosed, FCAS automatically determines the consequences of the failure. For example, if a Power Distribution Unit (PDU) fails, all of the components that are powered by the PDU will stop functioning. The ACAWS and FCAS outputs were displayed at the ACAWS console in a control room at JSC. During the test, ACAWS and FCAS successfully detected, diagnosed, and assessed the consequences of six injected failures, plus several real failures. The DSH flight controllers used ACAWS and a few came to rely on it.

For more information:

http://www.nasa.gov/centers/ames/cct/technology/stp/gamechanging/autonomous_systems.html

The ACAWS console in a control room at JSC.

The Game Changing Development (GCD) Program investigates 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 GCD, please visit
http://gameon.nasa.gov/

The second-generation Deep Space Habitat at JSC.

The Kennedy Space Center Cryogenic Test Bed Laboratory.

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