Intelligent systems

In 2005, intelligent systems technology applications continued to create and demonstrate important new capabilities in numerous NASA and DOD contexts. Several investigations were conducted to increase the robustness and safety of future systems in areas such as UAVs, system health management, distributed control, teleoperation of robots, and on-orbit autonomy.

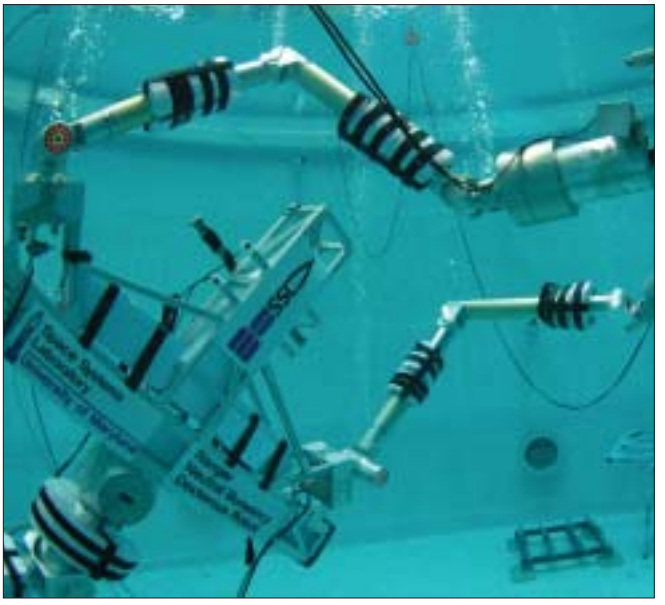
The Software Enabled Control program rotary-wing final experiments took place in August at the McKenna Urban Operations Site in Fort Benning, Ga., and included operation of the GTMax, a research UAV based on the Yamaha R-Max helicopter, and a 5-lb ducted-fan UAV. These tests included adaptive flight control, fault detection/accommodation, envelope protection, vision-based navigation, and urban operations. The effort, sponsored by DARPA and the Air Force Research Laboratory (AFRL), was led by the Georgia Institute of Technology in collaboration with Draper Laboratories, Vanderbilt University, Scientific Systems, Oregon Graduate Institute, Honeywell, and Boeing.

Several NASA-sponsored projects seek to increase the technical readiness level of technologies needed to implement an integrated system health management (ISHM) capability in the Crew Exploration Vehicle, space platforms, and Moon and Mars stations. NASA Stennis and NASA Johnson are leading a project focused on maturing core technologies for embedded ISHM capability, including an architecture/taxonomy/ontology, intelligent sensors, and intelligent components such as tanks and valves. At press time, a prototype implementation for a subsystem of a rocket engine test stand was planned for November 17. Another focus of the project is to establish ISHM test beds to develop/mature/validate ISHM technologies and capability. The test beds are based on rocket engine test stands and on the International Space Station.

A team at JPL is applying an integrated model-based systems and software engineering methodology to the development of a more capable and reliable monitor and control system for NASA's proposed 1,200-antenna Deep Space Network Array. This approach provides a state-based control architecture and a rigorous process for capturing system requirements in the form of explicit models, which directly inform the software design and goal-driven operations sequences. The framework has been implemented in Java and validated against a small-scale simulated array, demonstrating robust automated replacement of faulty antennas.

As part of NASA Goddard's investigation of robotic servicing options for the Hubble Space Telescope (HST), the University of Maryland Space Systems Laboratory (SSL) was tasked with modifying its Ranger Dexterous Robotic System to emulate the Canadian Special Purpose Dexterous Manipulator during robotic servicing simulations. A high-fidelity HST mockup was installed in the University of Maryland's neutral buoyancy tank, and the SSL completed a six-month series of robotic HST servicing tests. These tests demonstrated the feasibility of HST robotic servicing. Although the studies were cancelled in favor of a shuttle-based mission, Ranger is still used to investigate advanced robotics and automation technologies that support space exploration missions.

AFRL's Space Vehicles Directorate has been pursuing space-based intelligent systems technologies on several fronts. In support of the Air Force's Responsive Space initiative, the lab will fly several autonomy experiments on board the TacSat II satellite. These will include an on-orbit satellite checkout experiment, an autonomous tasking experiment, and an autonomous orbit control module. In addition, AFRL is investigating and implementing technologies that will allow Web-based satellite command and control, data dissemination, and user collaboration. The lab is also pursuing technologies that would perform detection and discrimination of satellite threats.



The Ranger Dexterous Robotic System performs an underwater HST fine guidance sensor changeout in the University of Maryland Neutral Buoyancy Research Facility.

by the AIAA Intelligent Systems Technical Committee