Intelligent systems

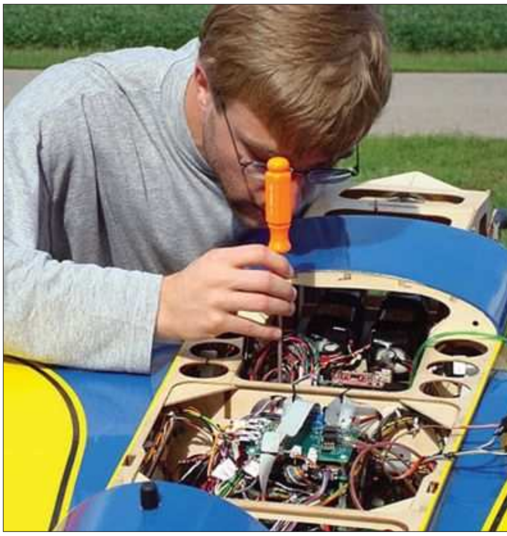
From intelligently directing robots on the ISS via smartphones to advances in verification for safety-critical systems, 2011 brought exciting developments across the spectrum of intelligent systems.

On the ISS, the SPHERES (synchronized position hold, engage, reorient, experimental satellites), originally developed by MIT, were equipped with smartphones running the Android platform, delivered by the last shuttle mission. By equipping them with smartphones, the NASA Ames Intelligent Robotics Group enables these self-propelled, volleyball-sized satellites to become capable robots, able to take pictures, record video, perform complex calculations, and transfer data in real time to the ISS and Mission Control. NASA will use the upgraded SPHERES to conduct visual inspections and numerous other tests (http://googleblog.blogspot. com/2011/09/android-in-spaaaace-part-2.html).

Researchers at JPL won the 2011 NASA Software of the Year Award for AEGIS (autonomous exploration for gathering increased science), which pushed the boundary for automated targeting and data collection onboard the Mars Exploration Rover Opportunity. AEGIS uses onboard data analysis to select rock targets in rover image data. If targets are found that match scientist-specified criteria, new targeted observations are automatically acquired without requiring interaction with human operators. AEGIS allows the rover to autonomously gather high-quality remote sensing data on scientifically interesting rock targets as soon as the rover reaches a new area.

Meanwhile, in aeronautics, the Samarai micro air vehicle achieved completely autonomous flights with all sensing, guidance, navigation, and control done onboard the wholly rotating MAV—a first for rotating mono-wing air vehicles. Developed by Lockheed Martin Advanced Technology Laboratories, Samarai weighs 7 oz and consists of a single 12-in.-radius wing powered by an electric motor/propeller at the tip and a servo-driven trailing-edge flap as the sole control surface. Despite this control surface limitation, its innovative MALCOLM (multi-application control of MAVs) algorithms achieved full authority control of the MAV in all degrees of freedom by automatically translating mission inputs into specific control objectives and intelligently allocating control between flap and throttle to preserve flap authority for maneuvering.

Responding to the need to prevent airspeed system failures like those contributing to the 2009 Air France Flight 447 disaster in which 228 people died, Galois and the National Institute of Aerospace developed a novel language and compiler called Copilot, for use in monitoring avionics software. Copilot is open source and generates hard real-time embedded C code from high-level behavioral specifications, providing in-flight software health management. With NASA Langley, the team tested its monitoring system on an airspeed system for a subscale unpiloted aircraft. Copilot monitors detected both software and physical faults injected into the system while meeting timing constraints (http://leepike.github.com/Copilot/).



A Copilot compiler monitors an airspeed system for a subscale UAV.

The Temporal Logic Planning Toolbox, TuLiP (http://Tu-LiP-control.sf.net), enables formal, automated synthesis of protocol-based control software for intelligent systems. To overcome the difficulty inherent in verifying complex intelligent systems after they are built, the toolbox is based on a shift from the traditional ‘design and verify’ approach for establishing trust to ‘specify and synthesize.’ Developers at Caltech conducted case studies including autonomous navigation and design of reactive, dynamic resource management logic for vehicle management systems.

Rice, Drexel, and the Universities of Michigan and Maryland furthered the reach of intelligent systems by designing a prosthetic arm amputees can control directly with their brains; the device also allows them to feel what they touch. Through a $1.2-million grant from the National Science Foundation’s Human-Centered Computing program, the project aims to tie together noninvasive neural decoding, direct brain control, and tactile sensory feedback into a single device. By providing sensory feedback in a natural way, this technology may also allow astronauts to see and feel through a robotic arm working outside the ISS from a virtual reality station inside. http://www.media.rice.edu/media/NewsBot.asp?MODE=VIEW&ID=15983&SnID=18803147o.

by **Kristin Yvonne Rozier**