Applying computation for security, efficiency

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*The **Intelligent Systems Technical Committee** works to advance the application of computational problem solving technologies and methods to aerospace systems.*

Robonaut 2 completed its fixed-base activities onboard the International Space Station and received its climbing legs in August 2014. R2's torso finished stanchion activities by manipulating space blanket materials, demonstrating increasingly difficult hand movements, and performing tasks under teleoperation control by astronauts wearing motion capture equipment and virtual-reality visors. Advanced tactics included grabbing a tumbling roll of tape in microgravity and manipulation of tethers, connection hoses and clamps.

In the domain of cyberphysical systems, aircraft including the unmanned variety utilize off-vehicle network connections for command and control, sharing sensor data and coordinating missions. Such connectivity can expose software vulnerabilities exploitable by cyberattackers. Experts working under **DARPA**'s High-Assurance Cyber Military Systems program, or **HACMS**, including Rockwell Collins, Boeing, the National Information Communications Technology Australia Center, Galois and the University of Minnesota, are building software to be provably secure against many classes of cyber attacks based on a high-assurance autopilot software stack with system architecture models for formal analysis. According to DARPA Program Manager Kathleen Fisher in January, DARPA's **Red Team** was unable to hack the team's research quadcopter given six weeks and full access. Research is transitioning to Boeing's **Unmanned Little Bird** helicopter.

To encourage earlier and broader adoption of formal methods within system development, the Centre of Informatics at Brazil's Universidade Federal de Pernambuco in Recife released **NAT2TEST**, an application that automatically generates test cases from **natural language** requirements. NAT2TEST analyzes the requirements' syntax based on a controlled, fixed grammar natural language; uses thematic roles to form the initial interpretation; and derives an abstract formal model from which alternative formal notations and test cases are generated. NAT2TEST was compared against random and specialist-written test cases and outperformed both of them when demonstrated on an **Embraer** aircraft's priority command controller and a **Mercedes** automotive turn indicator system.

To improve unmanned combat aerial vehicle operations, the University of Cincinnati's Morphing and Optimization Systems Technology for Aerospace Laboratory and the Air Force Research Lab Control Science Center of Excellence created the Learning Enhanced Tactical Handling Algorithm. **LETHA** utilizes multiple intelligently designed fuzzy systems to hierarchically break down the control of the aircraft and allow for the learning capabilities of genetic fuzzy systems to be applied to problems with larger complexity and scale. Set for release by **Psibernetix Inc.**, LETHA increases the efficiency, scalability and transparency of uninhabited operations by integrating self-defense missiles, laser weapon systems, mission planning, communications and responses to off-nominal conditions.

In the field of big data and domain-specific machine learning techniques applied to aircraft turbulence, researchers are re-envisioning models of **turbulent fluid flow** with previously unavailable accuracy. Funded through NASA's **LEARN** research support project for educators, researchers from the University of Michigan, Stanford University, Iowa State and Pivotal Inc. are utilizing large-scale data-driven simulation techniques to enable the construction of more accurate turbulence models infused with knowledge directly derived from large amounts of data from higher-fidelity simulations and experiments. This team is rethinking the way that turbulence models are created and embedded into flow solvers by generating an online database of curated test cases open to the modeling community.


Robonaut 2,with its freshly installed climbing legs, will be able to assist astronauts on the space station.

NASA

Working within the domain of flight safety, piloted simulations by **NASA Glenn** researchers demonstrated a new software algorithm called the **Model-Predictive Automatic Recovery System**. This software protects aircraft on the verge of a loss-of-control accident, especially during an unstabilized approach. The on-board model continuously predicts if the aircraft is able to perform a go-around from its current flight condition without dropping below a specified altitude, taking over control only when it determines that any delay to initiate a go-around could result in an accident. The system prevents dangerous situations, such as approaching too low and too slow, like the Asiana flight 214 into San Francisco in July 2013.