

Tech focus

This month's section focuses on autonomous vehicles.

Autonomous capability advances via SAE standard

Validation and implementation of an SAE standard that can be used as the basis for interoperability among autonomous air, ground, and marine vehicles is edging closer to finalization.

Parag Batavia of **Applied Perception**, who heads a subcommittee of the SAE AS-4 Unmanned Systems Committee, described as "pretty successful" an experiment conducted during the last week of April at Tyndall Air Force Base in Panama City, FL. By week's end, multiple vehicles were able to communicate with each other and simultaneously carry out assignments using the protocols defined in the standard.

The experiment involved four small surveillance vehicle-robots and two larger vehicle-robots. The robots were split up into two teams, with units being switched between teams periodically. On each team, two surveillance robots were paired with one of the two large vehicle-robots. The job of the surveillance robots was to police a perimeter (as if surrounding a munitions stockpile). The job of the large robots was to respond to the scene when notified by a surveillance robot of an "intruder."

In terms of interoperability, each of the robots behaved as hoped, according to Batavia.

"That scenario exercised a number of new capabilities of the JAUS (Joint Architecture for Unmanned Systems) message set," Batavia said, "including things like mission planning, mission task decomposition, and world model knowledge store."

World knowledge store refers to the information a surveillance robot obtains during its operation, such as terrain, position of intruders and intruder characterization—"whatever information sensors can provide," said Batavia. The idea is for the robot to propagate the information it collects to other nodes in a particular network (in this case, other robots and the control unit).

The Tyndall experiment was all about communication among robots, not vehicle or sensor capability. So, visually, the experiment was not terribly exciting. "It's

what's going on under the hood that really matters," Batavia said. He noted that in addition to demonstrating that the robots were able to speak to one another, the experiment was also helpful in testing several "technical concepts" of JAUS such as dynamic registration.

Although the experiment involved autonomous ground vehicles, the same level of success would have been achieved had an experiment of similar complexity been done using unmanned aerial vehicles, according to Batavia. "The emphasis currently is on ground vehicles, but the scope is broadening very rapidly with the recognition that addressing just ground vehicles isn't enough."

A NATO standard that the U.S. military now uses for autonomous aircraft does not have sufficient bandwidth to function for submarines and other undersea equipment such as torpedoes. JAUS does have that capability. Bandwidth and message sequencing are some of the elements of communication that the standard addresses.

"The Tyndall experiment demonstrated some of the advances in the JAUS architecture, the framework, and the message set," he said. For autonomous operation of multiple vehicles, he noted, "You have to figure out what type of information to send to be able to do certain types of



SAE AS-4 Unmanned Systems Committee member Parag Batavia of Applied Perception was encouraged by the success of the recent experiment in interoperability among autonomous vehicles.

actions. That's the big thing: Figuring out what information you need to send. And everybody has to agree on the format. So I can go and write my computer software to implement those messages, and the Air Force can write its version of the same software to implement those messages, and the Navy can do the same thing. So can **iRobot** and other private companies. And then we all come together and we say, 'OK, all of us have written



Among the surveillance robots used in the recent JAUS experiment were Harris Corp.'s ADAM (left), which uses Applied Perception's JAUS software suite, and Virginia Tech's Matilda, which was retrofitted for JAUS compliance.



One of the larger responder robots used in the experiment was the University of Florida's Navigator.

our own software, each of which is supposed to speak the same language; are we really speaking the same language right now?' That's what interoperability is all about."

With interoperability, an organization setting up network of autonomously operated air, ground, and/or sea vehicles can deploy such units (plus controllers)

from any company that makes them JAUS-compatible. "So, you're not reliant on any one vendor's product to execute missions. You can, to a certain extent, pick and choose," Batavia said.

One of the Tyndall event's highlights was the ability of an organization participating in a JAUS experiment for the first time to get its robot to operate with others. The organization, **Virginia Tech**, brought its Matilda robot. "It was pretty impressive to see that folks coming in without having spent years working on this can just take the specification and with a little bit of additional effort over a couple of weeks integrate their robot," said Batavia. "For me, that's validation of what JAUS is trying to do. The more people you can bring in with minimal effort, the more successful the standard is."

The first day of the experiment was devoted verifying that the various robots and controllers could talk to one another. Having access to a compliance tool from **Autonomous Solutions** for this purpose

reduced the amount of time (compared with previous experiments) spent by participants on debugging. The intruder scenario was played out in subsequent days, initially with way points communicated to one robot at a time, then to multiple robots simultaneously. "Then we started integrating some of the world model components so that we could detect the intruder automatically, pinpoint its location, and have the response vehicle sent," Batavia said.

All of the companies, universities, and military bases mentioned in this article were involved in the Tyndall experiment, in addition to the following: the **U.S. Army Aviation and Missile Research, Development, and Engineering Center; U.S. Air Force Research Labs; the University of Florida; Harris Corp.; U.S. Navy Naval Surface Warfare Center; SPAWAR Systems; CoroWare Test Labs; and Defense Technologies.**

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Northrop Grumman UAV in anti-drug-smuggling role

Add to the list of Global Hawk capabilities the detection of low-flying planes and fast-moving boats involved in drug smuggling.

Northrop Grumman's unmanned aerial vehicle (UAV) recently demonstrated those capabilities as required by congressional mandate. The areas observed from the Global Hawk's 60,000-ft perspective included the southern U.S., the Gulf of Mexico coast, and into the Caribbean Sea—areas known for major drug-trafficking routes.

There were two goals during the three flights, each of which lasted 28 h. One was to show that Global Hawk's sensors could detect low-flying airplanes from 60,000 ft. The second was to demonstrate the UAV's maritime sensor capabilities. Each goal was accomplished.

The flights were controlled from Northrop Grumman's Unmanned Systems facility in San Diego, CA.

During test flights, Global Hawk's integrated sensor suite successfully detected, tracked, and imaged maritime targets as well as detected and tracked airborne targets at several locations off the Gulf coast.

After all pre-planned targets were located, the Global Hawk flew on to the Caribbean, where it located multiple maritime ad hoc targets of interest. The target locations were relayed to a U.S. Navy P-3 Orion surveillance plane in the area, which confirmed and classified the targets.

"This exercise demonstrated how the Global Hawk system could assist military combatant commanders and homeland security officials stem illegal drug traffick-



The Global Hawk's tracking and imaging were proved in a recent anti-drug-smuggling demonstration.



Portions of the Global Hawk fuselage will be built at Northrop Grumman's Moss Point, MS, production facility.

ing in the air and on the water," said James Kohn, Northrop Grumman Program Manager for the demonstration.

The Global Hawk system features a UAV that flies at altitudes up to 60,000 ft, above inclement weather and prevailing winds. It can survey vast geographic regions with pinpoint accuracy. After mission parameters are programmed into Global Hawk, it can take off, fly its mission, and land autonomously.

In another matter involving the Global Hawk, Northrop Grumman in April opened a UAV production facility in Moss Point, MS, for, among other things, the metallic portions of the Global Hawk fuselage. Also to be produced there is the MQ-8B Fire Scout. Employment at the \$13 million, 101,000-ft² plant is expected to reach 60 by year's end.

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Sensor suite lightens UAV load

When it comes to unmanned aerial vehicles (UAVs), the lighter the better.

Lightness is a big selling point for **Optical Alchemy**, which offers a sensor package for UAVs that it claims has a mass 55 lb lighter than what would be required using conventional technology. The company's sensor suite enables military personnel to sense, detect, recognize, and track key targets.

Optical Alchemy President Marc Daigle noted that 55 lb of additional fuel would increase some UAVs' fly time by 5 h.



Optical Alchemy says its sensor suite contained in an 18-lb gimbaled turret can help extend UAV fly time and range.

The inertially referenced stabilized sensor suite (the KJ product line) comes in a single 18-lb gimbaled turret as well as smaller packages. It provides flexible, configurable payloads including high-resolution IR and visible sensors, laser range finder, laser marker, and laser designator to enhance force protection and provide on-demand actionable information.

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