Flying Airbus’s Augmented Reality System In A Mil Mi-2

Airbus is honing 3-D technologies for degraded visual environments

John Croft | Aviation Week & Space Technology

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Fused Reality

From 250 ft. above, the brush and cacti of one patch of desert look like the brush and cacti on any other sector in the flatlands west of Marana, Arizona. But don a prototype helmet and visor worthy of comic book hero Tony Stark’s “Iron Man” mask, and the desert comes alive with 3-D visuals that simplify and indemnify the practice of low-level helicopter operations in austere environments.

My dose of augmented reality came courtesy of a demonstration flight of an Airbus helmet-mounted display (HMD) from the left seat of the University of Iowa’s Mil Mi-2 avionics testbed, a Cold War-era helicopter with a high-tech cockpit flown by the head of the college’s Operator Performance Laboratory (OPL), Tom Schnell. Airbus Defense and Space builds the Sferion line of pilot-assistance aids, including avionics for degraded visual environments and obstacle avoidance.

While augmented reality—digital information fused with sensor information and natural vision—is old hat for the consumer electronics and gaming industries, it is relatively new for aerospace.

CREATING A SAFETY NET WITH AUGMENTED REALITY:

» Terrain data fused with real-time sensor information to generate a virtual world view
» 2-D and 3-D symbology is overlaid on worldview for heightened situational awareness
» Natural vision is replaced in degraded visual environments

The most pressing need for rotorcraft is to ensure that pilots receive critical landing and takeoff cues in so-called degraded visual environments (DVE), where natural vision is
blocked by night, dust, snow, smoke or other obscurants. The enhanced situational awareness benefits are not limited to helicopters and pilots wearing helmets; augmented reality can be advantageous on head-down displays and new generations of lightweight head-mounted or “near-to-eye” displays being developed by Thales, Honeywell, Elbit Systems, Rockwell Collins, BAE Systems and others for business and commercial aviation.

My flight took place Sept. 27, 2016, at the tail end of a DVE demonstration conducted by an Airbus and OPL team at the U.S. Army’s Yuma Proving Ground in southwestern Arizona. Yuma is popular for its soil, which when tilled and whipped up by the downwash of rotors, creates a talcum-like dust cloud that rises and robs pilots of all external vision. With dirt or sand, the effect is called brownout; snow renders a whiteout condition.

In either case, the favored solution to DVE involves three aspects to help pilots maintain situational awareness: active sensor information fused with digital terrain elevation data and obstacle and power line databases on a display, 2-D and 3-D conformal symbology also on the display, and flight control automation on the helicopter. The testing here focused on the first two legs of the stool because the Mi-2 does not have an autopilot. This endeavor is separate from the ongoing work within the U.S. Army, Navy, Special Forces and DARPA to find solutions to DVE as well as object- and wire-strike and controlled-flight-into-terrain accidents.

Sferion’s brownout testing was conducted on behalf of NATO’s Industrial Advisory Group, a team of experts from NATO member countries that provide technical input for military issues, in this case DVE. In February, Airbus will continue testing its DVE system in the fog, rain and snow in Germany and Switzerland using a Swiss air force Eurocopter EC635. “You can’t find brownout in Germany,” says Thomas Munsterer, product lead engineer for situational awareness solutions at Airbus Defense and Space.

Munsterer operated the DVE system computers in the passenger compartment of the Mi-2 for our flight. Visuals were displayed in front of my eyes using a BAE Systems prototype HMD, similar to the Striker 2 system on Eurofighter Typhoon and Gripen fighter jets. I found the helmet, which uses a binocular combiner to present the 2-D and 3-D symbology in a monochrome 40-deg. field of view onto the back side of the visor, to be light and comfortable to wear. Jellybean-size bumps on the helmet’s exterior are tracked by several cameras placed around the cabin, synchronizing the sensor and computer-generated imagery to my view of the outside world no matter what direction I turned my head. The symbology changed depending on the phase of flight. For example, below a certain speed, a hover mode appears.

The HMD is wired to rack-mounted computers that fuse terrain and obstacle databases with real-time forward-looking “point cloud” information from a SferiSense 500 Lidar (light-detection-and-radar) camera. The sensor data is overlaid with typical 2-D flight symbology (horizon line, flightpath vector, altitude and vertical speed tape and ground speed) and new 3-D elements (terrain-conforming gridlines, obstacles 16 ft. or more in height, ridgelines, waypoints and a landing zone “dog house”). The Lidar sensor is mounted to an outrigger on the left side of the Mi-2 next to a Goodrich short-wave infrared camera. The IR camera output for this test was shown only on a head-down...
While Lidar does not have the obscurant penetration capability of 94 GHz pulsed radar (the active sensor in Sierra Nevada Corp.'s DVE solution), the pulsed laser technology has a higher 3-D resolution and can map the landing zone terrain before the dust cloud becomes too thick, and during the brownout when “holes” open up during the event. “Brownouts are never complete,” says Munsterer. “There may be a hole that opens up where the sensor can grab another bite of data.”

Our afternoon flight took place at the Marana Regional Airport, 20 mi. northwest of Tucson. I met with Munsterer, Schnell and other team members for a preflight briefing to discuss the specifics of the HMD system and the flight plan—a hop across the desert and into the Silver Bell Mountains to show off the terrain and obstacle-awareness functions and back to the airport for a DVE landing demonstration.

Schnell flew the Mi-2 from the right seat, which allowed me to focus on the HMD and its controls—a brightness knob and a switch to cycle through the various visual features, both mounted on the left-side collective control handle.

In the visor, the pilot sees a horizontal compass tape at the top of the display; a vertical speed and rate-of-climb bar on the right side; a horizon line and pitch marker, a flightpath vector that shows the helicopter’s position relative to the terrain, obstacles or runway; and waypoints on the flight plan. Waypoints display as a vertical line with a four-point star at the top. Above the star, a tick mark shows the direction of the next waypoint. A section of text at the bottom right of the screen names the waypoint, as well as the heading and distance to it.

Underlying the entire scene are terrain grid lines composed of 100 X 100-m (328 X-328 ft.) squares that bend and contort based on the database terrain and obstacle models and the real-time returns from the Lidar. All graphics in the helmet are monochrome at this stage in the development, and depending on how many features are selected, the augmented reality can feel visually cluttered, particularly if the Lidar is set up to display every point-cloud return of all obstacles. However, Schnell points out that in brownout conditions or dark of night, “it’s information you do appreciate.”

As we departed the airport flying west, we observed several power lines that were hard to spot visually but were very apparent in the HMD presentation as vertical poles and cross beams with straight-line wires between poles. The system uses the real-time Lidar information to update the actual position of the power line information stored in the obstacle database.

Once we neared the mountains, Munsterer turned on a ridgeline overlay (derived from the terrain database) that shows the outline of ridges and mountains ahead, a particularly useful feature given that the flightpath vector shows whether the helicopter is clear of terrain. Schnell also demonstrated the benefits of the Sferion dynamic “safety line” technology, a constantly changing segmented line along the flightpath that shows how high the helicopter must fly to avoid terrain and obstacles out as far as 1,200 m ahead. “Keep the flightpath vector above the safety line and you are safe,” says Munsterer. The safety line, which is already available on Sferion products, takes into account the flight trajectory, speed and maximum climb rate.

Arriving back at Marana, Schnell demonstrated the landing zone (LZ) features developed for DVE and brownout situations. When passing a final approach waypoint located 0.8
nm from the LZ, a row of chevrons lights up and points to the landing location, shown as a “lollipop” (stick with circle at the top). At 600 m out, the Lidar measures the slope of the landing spot and depicts the information as a ball inside the lollipop symbol. When closer than 180 m, the landing zone symbology—a series of towers that outline a doghouse-shaped landing area grid with the touchdown zone shown as a circle the size of the main rotor—appears. Closer in, bold vertical lines rising along the towers show the altitude of the helicopter above the touchdown area.

While the landing symbology is a nicety for landing in clear weather with external cues available in the HMD, it becomes a necessity in DVE situations such as brownout. “When the brownout starts, you feel like you’ve stopped, even though you’re still moving,” says Schnell of the Yuma tests, where brownout causes a loss of approximately 100 deg. of peripheral vision beyond the edges of the HMD. Without the DVE tools, he says there’s a powerful instinct to push forward on the controls.

“I’ve lectured about this stuff; now I can actually understand it,” he adds.
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