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NASA research team envisions flock of robot aircraft monitoring wildfires

By Bruce V. Bigelow
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Using the sort of small robotic aircraft flown by the military in Iraq, a NASA research team has developed techniques for launching a fleet of unmanned aircraft like a flock of birds to monitor fast-moving wildfires.

Flight tests of the concept were first conducted almost a year ago by researchers at NASA's Dryden Flight Research Center, near Edwards Air Force Base. It was showcased again last month in flight demonstrations for state and federal fire officials at Moffett Field in the Bay Area.

NASA Ames Research Center / Associated Press
Steve Morris prepared to launch the MLB Bat, an unmanned aerial vehicle, from atop a car at Moffett Field near Mountain View last month. UAVs have been tested for firefighting use.

"A lot of people need this technology," said Stanley Herwitz, who heads a team at NASA's Ames Research Center, near Mountain View, which specializes in UAVs, or unmanned aerial vehicles.

Among the innovations used by the NASA researchers was flight control software that enables multiple UAVs to simulate the random-but-choreographed aerial ballet of a flock of birds.

San Diego's devastating Cedar fire was one of the primary reasons the program began last year, said John Melton, a NASA scientist who helped lead the research. The October 2003 wildfire destroyed more than 2,200 homes and killed 15 people in San Diego County.

The NASA researchers envision sending two or three small UAVs to circle about 1,500 feet above a wildfire, transmitting video images to firefighters on the ground. Using unmanned planes instead of piloted spotter aircraft would provide a continuous "eye in the sky" for eight hours or more.

The researchers also say flocks of spy planes could be sent to scout for lightning strikes after a summer storm moves across a national forest.

But the idea of flying small unmanned planes close to backcountry infernos has raised several concerns, including potential conflicts with other aircraft – such as air tankers dropping fire retardant.

"You'd be putting UAVs into a dangerous environment where there are a lot of other aircraft," said Philip Riggan, a wildfire scientist with the U.S. Forest Service's Pacific Southwest Research Station in Riverside.

But Herwitz, a professor of Earth science at Clark University in Worcester, Mass., said he also has plans to develop a portable, ground-based radar system. Such a system could be used like a mobile air-traffic control system to help UAVs avoid piloted aircraft, he said.

"People who are thinking about all the bad things that could happen are getting ahead of themselves," Herwitz said. "They need to think about all the good things that could happen."

In the Dryden flight tests, two small UAVs flew without guidance from ground controllers. The flight control software installed in the computerized auto-pilot aboard each plane enabled the aircraft to fly close to each other and to automatically swerve around computer-generated obstacles. The robotic aircraft used were APV-3s, propeller-driven planes with 12-foot wingspans made by RnR Products of Milpitas.

Melton said the NASA team worked on the underlying technology in a project that resembled the atmosphere of aviation innovation at Lockheed's "Skunk Works."

The flight control software was based on pioneering work by Craig W. Reynolds, a computer scientist who developed programs to simulate the coordinated movements of flocks of birds and schools of fish. Hollywood adopted such research to create computer-generated scenes in films such as *Jurassic Park*, and Reynolds received an Academy Award in 1998 for his innovations in the development of three-dimensional computer animation.

UAVs using such technology also could be used in civil disasters, the NASA team said.

Flocks of small UAVs could investigate toxic chemical spills or radiological accidents without risks to pilots. Plans also have been laid by the Department of Homeland Security to fly UAVs in Border Patrol duty.

Such requests for using UAVs have prompted NASA, the Federal Aviation Administration and others to develop regulations and technologies that could make it easier to fly UAVs in civilian airspace. Under current rules, UAVs are permitted to fly in civilian airspace under a certificate of authorization that requires the operator to file a flight plan with the FAA at least 30 days in advance.

The FAA plans to relax that standard by issuing its first experimental certification in the next month, said Cyndi Wegerbauer, a spokeswoman for the collaborative effort.

Riggan, the fire scientist, has been working for several years to develop technologies for imaging wildfires from a piloted, twin-engine Beech King Air. He said he agrees that there is a need to produce real-time imagery and related information for firefighting personnel.

But whether the imaging is done from a piloted aircraft or a UAV is less important to Riggan than resolving a series of other issues, such as transmitting imaging data to the appropriate firefighting officials.

Qualcomm, the San Diego wireless communications giant, has responded by providing a prototype of its MDSS Globalstar Communications System, which uses a satellite to relay data between the plane and ground.

Transmitting such data to fire incident commanders in remote backcountry areas is another hurdle, though.

"The advantage of using UAVs on fires is that you could potentially circle above a fire for 24 hours, or perhaps as long as 36 hours," Riggan said. "The thing that the UAV addresses is going to be important, but it's probably not our weakest link right now."

In any case, Riggan contends it would be more useful to get images from much higher altitudes.

The Global Hawk, a high-altitude robotic reconnaissance jet developed in San Diego for use by the military, was used to take images of a high desert wildfire on July 6.

"Global Hawk has the advantage of broad-area coverage," said Ed Walby, a director of business development for Northrop Grumman, which builds the jet for the military. "Carrying multiple sensors aboard the same platform allows you to take multiple images of something."

Walby added, "We came to the conclusion that you can fly over a forest region and survey the entire forest, let's say Sequoia or Yosemite, in an hour or so."

But Global Hawks, which cost millions of dollars apiece, could be too expensive for firefighting agencies, which frequently struggle to meet their budgets.

NASA researchers plan to use another unmanned spy plane developed in San Diego, the Altair, to fly fire surveillance missions next summer over several Western states. The Altair, built by General Atomics Aeronautical System, has a wingspan of up to 84 feet and can fly at altitudes as high as 52,000 feet for more than 30 hours.

Even that approach may prove too expensive to be practical, NASA's Melton said.

"The Forest Service is looking for things that they can launch out of the back of their pickup truck," Melton said. He noted that small UAVs, such as the APV-3 or the rival MLB Bat, cost less than $50,000 apiece and are relatively easier to launch and operate.

Another advantage to such UAVs, Melton said, is they can be designed to fly at night – a time when retardant-dropping tankers and other firefighting aircraft typically stay on the ground.

"There is potentially a nice fit here, where you could do your water attacks and use your manned aircraft during the day, and fly the UAVs at night. The UAVs then could feed that data to the incident commander, who could look at it first thing in the morning."

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