

## Multiple UAVs perform autonomous formation flight (w/ Video)

August 8 2014, by Jason Maderer

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The Georgia Tech Research Institute (GTRI) uses quarter-scale Piper Cub aircraft for research on collaboration between unmanned aerial vehicles. Shown with the aircraft are (l-r) Lora Weiss, Gary Gray, Don Davis and Kyle Carnahan. Credit: Gary Meek

(Phys.org) —These days, unmanned aerial vehicles (UAV) typically fly alone with a team of ground operators controlling their activities through teleoperation or waypoint-based routing. But one aircraft can only carry so many sensors, limiting its capabilities. That's one reason why a fleet

of autonomous aircraft can be better than one flying alone.

In one of the first autonomous demonstrations, the Georgia Tech Research Institute (GTRI) has successfully commanded three fully autonomous, collaborating UAVs. The machines flew in close formation at the same altitude, separated by approximately 50 meters as they executed figure-eight patterns. The research is part of GTRI's efforts to improve the capabilities for [autonomous systems](#) collaborating as teams, thereby reducing the load on human operators.

"For autonomous systems to scale effectively, future systems will need the ability to perform with a higher level of autonomy," said GTRI Chief Scientist Lora Weiss, who leads GTRI's UAV research. "Human operators must be able to provide high-level task descriptions, allowing the systems to figure out for themselves how to dynamically form teams and autonomously collaborate to complete tasks."

GTRI operated the three UAVs over the skies of Fort Benning near Columbus, Georgia. A single plane was initially designated as the leader and commanded to fly autonomous orbits. The two "follower" UAVs joined the orbits, flying with rotational offsets of 15 and 30 degrees, respectively, from the leader.

"There are logistical challenges with quickly getting multiple planes in the air," said Charles Pippin, a GTRI senior research scientist who led development of the autonomy algorithms.

The lead UAV shared its current position with the follower UAVs several times per second, allowing the followers to calculate the control changes necessary to reach the desired position. The followers also used the leader's information to send commands to their on-board autopilots, which adjusted the controls and throttle for each [aircraft](#). GTRI's autonomous algorithms and applications are general enough that they can

be used with different UAVs and autopilot systems.

The aircraft in the Fort Benning demonstration were quarter-scale Piper Cub airframes with a wingspan of approximately eight feet. They are able to carry a mission computer, autopilot system, and sensor payloads.

Autonomous systems working in teams have numerous future applications designed to improve lives and reduce costs. For example, multiple UAVs could provide several different camera angles while searching for a missing person. While surveying hurricanes, one plane could carry a sensor to check wind speed in one area while another UAV measures energy in another. The same is true for wildfires. One vehicle could determine the size of the blaze while another uses different sensors to measure the heat or direction of the inferno.

"Multiple planes working together also provides flexibility if one aircraft fails or is diverted somewhere else during a mission," explained Pippin.

As the use of unmanned systems becomes more prevalent, increasing levels of autonomy will become necessary to improve the safety, robustness, and quality of these systems. GTRI's unmanned systems research has the potential to positively impact many different industries, including crop inspection and spraying, delivery of goods, wildlife management, and utility inspection

"GTRI's ongoing research in these areas will make UAVs safer, and cheaper to operate," said Weiss.

GTRI currently conducts collaborative UAV research using a collection of different airframes. GTRI has modified these aircraft in different ways, including equipping them with RF modems and cameras. The aircraft can also be equipped with pods to carry customer-specific payloads. The aircraft have been invaluable for research on collaborative

control of multiple UAVs and have enabled development of algorithms to support more sophisticated collaborative missions.

The recent UAV tests follow a 2010 GTRI demonstration at Fort Benning that featured two small-scale aircraft and a full-size self-driving automobile completing a mission without human interaction. The two projects are part of a Memorandum of Understanding GTRI has with the Army post to conduct tests of advanced technologies.

Provided by Georgia Institute of Technology

Citation: Multiple UAVs perform autonomous formation flight (w/ Video) (2014, August 8) retrieved 21 September 2024 from

<https://phys.org/news/2014-08-multiple-uavs-autonomous-formation-flight.html>

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