Automating complex design of universal controller for hybrid drones

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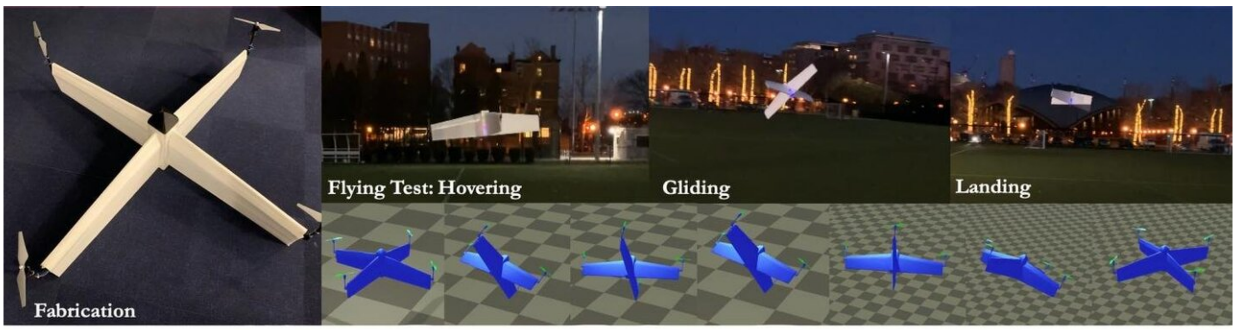

Hybrid unmanned aerial vehicles, or UAVs, are drones that combine the advantages of multi-copters and fixed-wing planes. These drones are equipped to vertically take off and land like multi-copters, yet also have the strong aerodynamic performance and energy-saving capabilities of traditional planes. As hybrid UAVs continue to evolve, however, controlling them remotely still remains a challenge. Credit: Jie Xu

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A team from the Massachusetts Institute of Technology's Computer

Science and Artificial Intelligence Lab (CSAIL) has devised a new approach to automatically design a mode-free, model-agnostic, AI-driven controller for any hybrid UAV. The team will present their novel computational controller design at SIGGRAPH 2019, held 28 July-1 August in Los Angeles. This annual gathering showcases the world's leading professionals, academics, and creative minds at the forefront of computer graphics and interactive techniques.

To control hybrid UAVs, one system directs the vehicle's copter-model rotors for hovering and a different one directs plane-model rotors for speed and distance. Indeed, controlling hybrid UAVs is challenging due to the complexity of the flight dynamics of the vehicle. Typically, controllers have been designed manually and are a time-consuming process.

In this work, the team addressed how to automatically design one single controller for the different flight modes (copter mode, gliding mode, transition, etc.) and how to generalize the controller design method for any UAV model, shape, or structure.

"Designing a controller for such a hybrid design requires a high level of expertise and is labor intensive," says Jie Xu of MIT and coauthor of the research. "With our automatic controller design method, any non-expert could input their new UAV model to the system, wait a few hours to compute the controller, and then have their own customized UAVs fly in the air. This platform can make hybrid UAVs far more accessible to everyone."

The researchers' method consists of a neural network-based controller design trained by reinforcement learning techniques. In their new system, users first design the geometry of a hybrid UAV by selecting and matching parts from a provided data set. The design is then used in a realistic simulator to automatically compute and test the UAV's flight performance. Reinforcement learning algorithm is then applied to automatically learn a controller for the UAV to achieve the best performance in the high-fidelity simulation. The team successfully validated their method both in simulation and in real flight tests.

With the continued prevalence of hybrid UAVs—in the flight industry and military sectors, for example—there is a growing need to simplify and automate controller design. In this work, the researchers aimed to deliver a novel model-agnostic method to automate the design of controllers for vehicles with vastly different configurations.

In future work, the team intends to investigate how to increase the maneuverability through improved geometry design (shape, positions of rotors/wings) so that it can help perfect the flight performance of the UAV.

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