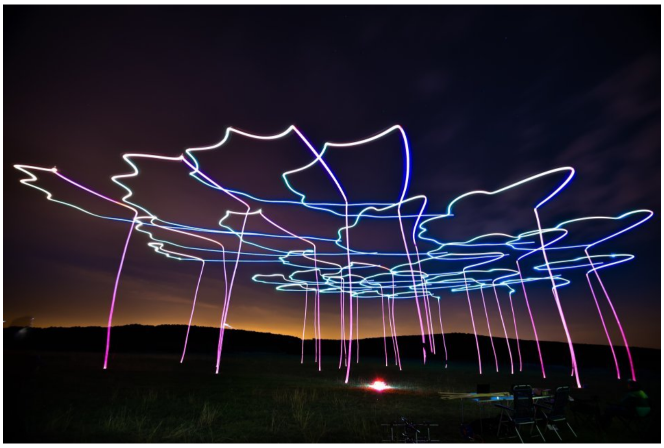
A better way to control a swarm of drones

19 July 2018, by Bob Yirka



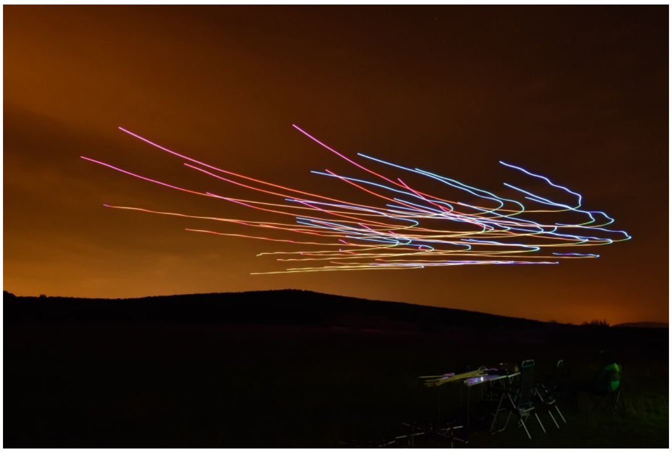
Drones light up the night sky. Credit: Zsolt Bézsenyi

A team of researchers from Hungary, Norway and the Netherlands has found a way to better control a large swarm of drones—give them more autonomy. In their paper published in the journal *Science Robotics*, the group describes their approach and how well it has worked in real drone swarms.

Most people have seen drone swarms in action—they have been used for colorful entertainment purposes at such events as the Super Bowl and the Olympics. The researchers with this new effort note that such drones are programmed in advance, and are therefore limited in ways they can be deployed. They note that pre-programming makes it almost impossible for drones to overcome unexpected problems such as wind gusts or temporary loss of communications. They suggest a better approach is to make the drones as autonomous as possible so they can determine what to do when unexpected events occur.

Giving swarm drones autonomy has not been easy. The researchers have been working on their project for over six years. The process has involved attaching GPS devices to birds to track and map how they interact in flocks. Simulations were developed to mimic the behavior of 100 birds and then 100 drones. Eventually, the team came up with 11 parameters (such as how quickly to align with other drones) critical for coordinated autonomous flight. They would tweak the parameters and then run a simulation on a supercomputer, note where things went wrong, tweak the parameters and run it again, over and over. Eventually, they report, their simulation became stable enough to convince them to try their approach with real drones.

To test their system, they built their own squad of 30 drones and sent them flying. They report that their squads have performed as hoped—thus far, there have been no collisions. In flight, they look eerily similar to the notorious swarms of starlings flying over Rome. Each of the drones maintains its position in the swarm by keeping in constant communication with the others, monitoring where it is in relationship to others, and how fast everyone is moving. And there is no leader. Each makes its own decisions regarding flight movements based on the movements of the others. The researchers suggest their behavior is very similar to that of flocks of birds or swarms of bees.



Drones light up the night sky. Credit: Zsolt Bézsenyi

More information: Gábor Vásárhelyi et al. Optimized flocking of autonomous drones in confined environments, *Science Robotics* (2018). [DOI: 10.1126/scirobotics.aat3536](https://doi.org/10.1126/scirobotics.aat3536)

Abstract
We address a fundamental issue of collective motion of aerial robots: how to ensure that large flocks of autonomous drones seamlessly navigate in confined spaces. The numerous existing flocking models are rarely tested on actual hardware because they typically neglect some crucial aspects of multirobot systems. Constrained motion and communication capabilities, delays, perturbations, or the presence of barriers should be modeled and treated explicitly because they have large effects on collective behavior during the cooperation of real agents. Handling these issues properly results in additional model complexity and a natural increase in the number of tunable parameters, which calls for appropriate optimization methods to be coupled tightly to model development. In this paper, we propose such a flocking model for real drones incorporating an evolutionary optimization framework with carefully chosen order parameters and fitness functions. We numerically demonstrated that the induced swarm behavior remained stable under realistic conditions for large flock sizes and notably for large velocities. We showed that coherent and realistic collective motion patterns persisted even around perturbing obstacles. Furthermore, we validated our model on real hardware, carrying out field experiments with a self-organized swarm of 30 drones. This is the largest of such aerial outdoor systems without central control reported to date exhibiting flocking with collective collision and object avoidance. The results confirmed the adequacy of our approach. Successfully controlling dozens of quadcopters will enable substantially more efficient task management in various contexts involving drones.