Self-organizing drone flock demonstrates safe traffic solution for smart cities of the future

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Post-processed image of the raw video footage of the field experiment with 100 drones performing autonomous decentralized traffic in two layers. The image was created iteratively, by adaptively averaging consecutive video frames into a background image, and then getting the pixel-level lighter color values from the current background and the new frame. The light indicator attached to each drone shows the status of the algorithm: green means free motion, blue means the drone is avoiding others, purple means the drone is queueing, white flash indicates that the target has been reached. Credit: Drone swarm research at ELTE Department of Biological Physics

After creating the world's first self-organizing drone flock, researchers at Eötvös Loránd University (ELTE), Budapest, Hungary have now also demonstrated the first large-scale autonomous drone traffic solution.

This fascinating new system is capable of far more than what could be executed with human pilots.

The staff of the Department of Biological Physics at Eötvös University has been working on group robotics and drone swarms since 2009. In 2014, they created the world's first autonomous quadcopter flock consisting of at least ten units. The research group has now reached a new milestone by publishing the dense autonomous traffic of one hundred drones in the journal *Swarm Intelligence*.

But what is the difference between flocking and autonomous drone traffic?

In the former, the goal of the units is to get perfectly synchronized through coordinated joint movement, such as in a bird flock. In a traffic situation, however, drones may have individual routes and goals, leading to potential conflicts. This is particularly true when traffic does not occur on designated routes but in open spaces, when pedestrians crossing a square in arbitrary directions or drones moving freely in the open sky.

The ELTE researchers solved this problem by combining a special, forward-thinking and real-time updating route planner with the interactions of traditional bio-inspired flocking models. Thus, the autonomous robots can optimally avoid most traffic conflicts and safely manage the remaining ones by directly coordinating with their neighbors.

The effectiveness of the completely self-organizing model, without central control, was first tested in simulations.

During this process, they were able to demonstrate the continuous high-speed random traffic of up to 5,000 drones in two dimensions with identical or different speeds and/or priorities. Even layered three-dimensional cases were mapped to illustrate the efficient solution of dense drone traffic situations for future smart cities and decentralized air traffic control concepts.

The model was then programmed onto a hundred-member drone fleet owned by CollMot Robotics Ltd.—a company founded at the Department of Biological Physics with the aim of drone swarm technology commercialization. The self-organizing drone traffic was demonstrated live with hundred drones.

Based on this solution, a new phase of automated swarm drone operations can start across a wide range of applications, from group spraying to drone-based cargo transport and defense industry applications.

All these goals are represented by CollMot Robotics Ltd., cooperating with ELTE in continuously pushing scientific results into industrial innovations.

More information: Boldizsár Balázs et al, Decentralized traffic management of autonomous drones, *Swarm Intelligence* (2024). DOI: 10.1007/s11721-024-00241-y

Provided by Eötvös Loránd University

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