Drones, ride sharers could team up for package delivery

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Naira Hovakimyan, a professor of mechanical science and engineering, directs the Advanced Controls Research Laboratory at the University of Illinois at Urbana-Champaign. Credit: College of Engineering, University of Illinois at Urbana-Champaign.

In the future, when you hail an Uber or take the bus, you might not only be sharing the ride with another traveler, but perhaps with a drone out on

delivery as well. That is the vision of Naira Hovakimyan, professor of mechanical science and engineering at the University of Illinois at Urbana-Champaign, who is leading a six-person, three institution (Illinois, Stanford, South Carolina) $1 million National Science Foundation (NSF) grant to see if drones and existing ride-sharing vehicles (RSVs) can provide synergetic delivery service in urban areas. The likes of Amazon, UPS, and the United States Postal Service are eagerly awaiting the outcome.

A recent study by McKinsey and Company found that 50 percent of all delivery costs occur in the "last mile" of delivery to the destination, and—with the demand for even quicker and cost-effective delivery by the consumer—solving that logistical dilemma is a big challenge for the industry.

"The major companies are in the process of developing their own network of cars and drones," Hovakimyan said. "Their solutions offer great flexibility to the consumer, but a single person can still only deliver one purchase order to a customer at a time, which it is not scalable or cost-effective."

What Hovakimyan and her team are proposing is to develop a network of drones and existing RSVs to carry a package to the final destination. For instance, a drone might take off from a delivery center carrying a package, rendezvous with an Uber or mass transit vehicle using magnetics to dock to the roofs of these vehicles even while in motion, and drop them off the package. Another drone close to the final destination would then intersect the package and take it directly to the doorstep of the consumer. Because the ride-sharing vehicles are already on the road and use GPS to guide them on a specific route, the drones can coordinate with them to make the best flight plan for the package. Eventually the delivery could involve several of these drop-offs along the way.

"By taking advantage of the existing network, we are addressing a complex mathematical problem, and if we address it correctly, we drop the delivery costs a few times. In the future the drivers may get a payment for simply agreeing to have packages dropped off on their vehicles. The car is driving along the same route anyway. Nothing needs to change. Based on the route we can obtain through their mobile device, we can determine the best vehicles to use through some bidding logic."

A native of Armenia with degrees in applied mathematics, theoretical mechanics, and physics, Hovakimyan has been applying her knowledge of mathematics for advances in flight control and other industries for some time. Over the past few years, she has been at the forefront in exploring logistics for the booming drone industry. Her startup, IntelinAir, for instance, is using aerial imagery to provide actionable analytics for farmers. An earlier NSF grant to her team explored using small drones for elderly care. It is through that study that she realized the importance of perceived safety. In other words, how safe will we feel with hundreds if not thousands of drones flying above and around us in a narrow space. That is why this team includes a psychologist.

"Apparently, humans are more scared of the velocity profile of the drones than by their size," Hovakimyan noted. "By learning about these issues—how to differentiate between perceived safety and actual safety—we were able to come up with path planning and collision avoidance algorithms for drones that would not scare people as much. Of course, we need to make sure we can operate these drones in a very robust way and that they can interact with each other, have path planning and collision avoidance, work on random networks, and be safe for society."

Cybersecurity is another big challenge. In order for the system to work, it will be need to be immune to attacks from hackers looking to take over the flight of the drone.

"We are working on autopilots that will be robust to hacking," Hovakimyan said. "In the end, they will all converge around having one framework that will have all the robustness against cyberattacks, against failures of physical components, network failures, and so on."

Initially, the packages using the system would be light, say 5-10 pounds, which covers a high-percentage of items ordered online. Eventually, Hovakimyan believes, the weight limit would increase.

"I think this technology will eventually be available in different sizes, in different operations, and for fulfilling different needs," Hovakimyan said. "The underlying mathematical framework is very rich and complex. It takes advantage of graph theory, information theory, game theoretical approaches for bidding, robust control, rendezvous with moving vehicles, hardware, magnetic docking, and so on. The future is coming sooner than what we imagine. We are trying to be at the forefront with the algorithms we develop."

Ultimately, she believes the likes of Amazon will be convinced that using drones and partnering with existing RSVs provide the most efficient method of delivery, saving them costs of gas, vehicle maintenance, and manpower currently needed to accomplish the last mile of delivery. They plan to work with those major companies on further stages of development on the project.

Provided by University of Illinois at Urbana-Champaign

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