Drones Ripe for Pervasive Use

Florian "Floyd" Mueller
RMIT University, Australia

Albrecht Schmidt
University Stuttgart, Germany

In recent years, there has been a proliferation of drones—or unmanned aerial vehicles (UAV)—thanks to technological advances that have made drones more powerful. Drones also now come in all sorts of shapes and sizes, ranging from professional systems for military use to small-scale toys for children.

Given this increase in drone numbers and use, researchers have started investigating how drones affect people—in terms of how they conduct their work, execute tasks, communicate with others, and interact with this technology. In addition, the increased availability of individual drone parts has made it easy for DIY communities to develop novel and interesting projects, creating opportunities across a wide range of new application domains. This special issue explores some of this research and the opportunities it presents.

The Nature of Drones

Drones have several characteristics that make them appealing to the research community.

First of all, they can navigate over uneven terrain. This lets them circumvent the problems of other navigating systems, such as wheel- or leg-based robots, which often struggle to cover nonflat surfaces.

In addition, their aerial view offers a unique perspective of the world. People can use them to gain a better understanding of hard-to-reach geographical areas.

Finally, people are starting to prefer drones over other aircrafts because they're more economical, smaller, and lighter. One initial appeal of drones was that they did not require a pilot onboard, thereby ensuring humans weren't at risk in military operations. Now, thanks to recent advances, drones are available at a fraction of the cost of a manned aerial vehicle, and their small size makes them easier to transport and launch. Furthermore, because they're lighter, they're more fuel efficient and, in the case of a crash, are often less likely to cause damage. These characteristics are helping drones move beyond military operations, making them ripe for use in pervasive computing.

However, drones aren't without their shortcomings. For example, they're very much affected by weather conditions. Also, drones that work with multiple propellers can produce a significant noise, making deployment in noise-sensitive areas challenging. In addition, propellers pose a safety hazard: rotary wings function as blades that can easily injure people. Safety cages exist, but because air must travel through these enclosures, they can never be fully closed, so there's always the risk of something getting caught in the moving parts of the system.

In the case of malfunctioning due to a hardware or software bug, there could be a physical crash of the system, possibly damaging not only the device but also any people or infrastructure located below it. Furthermore, battery power is limited, and designers must carefully manage the relationship between the size and capacity (that is, weight) to maximize the flying time and load capacity.

Finally, because most drones feature cameras, issues of privacy will become increasingly important, especially as drones get smaller and thus can easily survey areas previously inaccessible by camera operators. As with any pervasive computing technology, drones thus raise concerns about privacy and security, along with device visibility and control.[1]

Despite these shortcomings, drones provide an interesting area for future research, enabling novel opportunities.

Related Drone Research

Although initial drone research was mostly concerned with improving technical abilities—including battery power and flight accuracy—more recent research investigates how drones can support existing application domains and create new ones.

Instead of looking at the larger drones mostly used during military operations, this special issue focuses on smaller drones, which fly at lower altitudes and thus could play a more significant role in pervasive computing applications. Most of the currently popular drone systems, such as those used for aerial photography, agricultural and meteorological purposes, as well as fire services, are remotely controlled by an operator on the ground. However, autonomously controlled drones are becoming more popular in research operations, and we anticipate novel uses of such drones in future pervasive computing applications.

Examples of such drones include those serving as a delivery platform, enabling the easy transportation of goods from point A to point B in a fully automated fashion. Researchers have also suggested using small-scale drones as pixels of a pervasive 3D display that can move around freely within the space.[2] Other research has highlighted the potential of drones to serve as companions—for example, accompanying athletes to guide and encourage them during workouts.[3] Researchers have also suggested using drones to enhance remote collaboration tasks.[4]

Other research has highlighted the potential of drones to serve as companions—for example, accompanying athletes to guide and encourage them during workouts.

On a related note, there is also research underway that uses advanced sensor systems to enable obstacle avoidance, an approach that would facilitate much more advanced autonomous systems by letting drones dynamically respond to obstacles in the environment as they appear. Advancements of such systems will further the field by enabling entirely new application domains, where interactions between people and drones will be commonplace. Today, most drone instruction manuals still stress the need to operate drones away from people. In the future, with the aforementioned advances in obstacle avoidance, such interactions will be less dangerous; however, issues of noise and perceived danger will become of increased importance.

A more detailed introduction to the field of drones appears elsewhere.[5]

In this Issue

This special issue includes two articles on drones research as well as two related departments. In "Help from the Sky: Leveraging UAVs for Disaster Management," Milan Erdelj, Enrico Natalizio, Kaushik Chowdhury, and Ian Akyildiz present a vision for future drone-assisted disaster management that considers the functions of disaster prediction, assessment, and response. The authors argue that drones have an advantage in that they can provide wireless communication links between survivors and the nearest available cellular infrastructure. In fact, they highlight the potential of drones to provide underlying services to people who aren't even aware of the drones—for example, survivors in a disaster situation who use their mobile phones while a drone provides a wireless link to the nearest cellular infrastructure. The article will be of value to researchers and practitioners interested in understanding the potential of drones to supplement traditional means of communications in case of failure.

Unlike the disaster situation just noted, there are also scenarios in which people want to directly interact with drones—for example, to direct their flying path—but traditional HCI techniques might not be sufficient for such interactions with drones. In "Natural Interaction Techniques for an Unmanned Aerial Vehicle System," Ekaterina Peshkova, Martin Hitz, and Bonifaz Kaufmann provide a detailed overview of interaction techniques for controlling drones. They also consider how to control multiple drones—an aspect of scaling that's pertinent given the emergence of smaller drones, which could become so cheap that we find ourselves interacting with not just one or a few drones but hundreds of drones, as suggested by the drone work demonstrated at Ars Electronica. In such work, a large swarm of drones illuminates the night sky of Linz every year in a spectacular arts performance (see www.youtube.com/watch?v=eZ-js5zn-I0).

The issue also includes an Education department, "Design Fiction: Anticipating Adoption," by Paul Coulton and Joe Lindley. Coulton and Lindley demonstrate the *design fiction* method and how it can provoke people to think about a future in which drones become pervasive, encouraging them to consider how this could affect our culture.

Finally, this issue's Spotlight department features two separate pieces. In "Flying Displays and Drone-Assisted Art Making," Jürgen Scheible and Markus Funk suggest how drones might support art-making in public spaces. Then, in "Interactive Context-Aware Projections with Drones for Exergaming," Klen Čopič Pucihar, Matjaž Kljun, Mark Lochrie, Paul Egglestone, and Peter Škrlj explore the use of drones to support interactive bodily play between groups of people by augmenting drones with projectors and sensors that detect human movement.

The research presented in this issue showcases some of the challenges and possible solutions in making drones more useful for people. As better sensing technologies become available, improved obstacle avoidance will pave the way for more applications while simultaneously reducing the physical risk that drones currently pose to the environment. Furthermore, advances in power management will result in increased flying time, allowing larger missions to be executed that span longer durations.

With these new technologies becoming available to better support people in their use of drones, we might soon see drones emerge as one of the core components of a pervasive computing life. P

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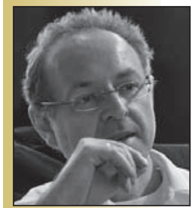
the AUTHORS

Florian "Floyd" Mueller is a professor at RMIT University, Melbourne, Australia, directing the Exertion Games Lab in the Centre for Game Design Research. He is interested in supporting people experiencing their bodies as digital play. Contact him at floyd@exertiongameslab.org.



Albrecht Schmidt is a professor at the University Stuttgart, Germany. His research interests are ubiquitous computing and context awareness. Schmidt has a PhD in computer science from Lancaster University. Contact him at albrecht.schmidt@vis.uni-stuttgart.de.