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Taking off: Autonomy for insect-scale robots

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Abstract: Countless science fiction works have set our expectations for small, mobile, autonomous robots for use in a broad range of applications. The ability to move through highly dynamic and complex environments can expand capabilities in search and rescue operations and safety inspection tasks. These robots can also form a diverse collective to provide more flexibility than a multifunctional robot. Advances in multi-scale manufacturing and the proliferation of small electronic devices have paved the way to realizing this vision with centimeter-scale robots. However, there remain significant challenges in making these highly-articulated mechanical devices fully autonomous due to the severe mass and power constraints. My research takes a holistic approach to navigating the inherent tradeoffs in each component in terms of their size, mass, power, and computation requirements. In this talk I will present strategies for creating an autonomous vehicle, the RoboBee – an insect-scale flapping-wing robot with unprecedented mass, power, and computation constraints. I will present my work on the analysis of control and power requirements for this vehicle, as well as results on the integration of onboard sensors. I also will discuss recent results that culminate nearly two decades of effort to create a power autonomous insect-scale vehicle. Lastly, I will outline how this design strategy can be readily applied to other micro and bioinspired autonomous robots.

Biographical Sketch: Farrell Helbling is an assistant professor in Electrical and Computer Engineering at Cornell University, where she focuses on the systems-level design of insect-scale vehicles. Her graduate and post-doctoral work at the Harvard Microrobotics Lab focused on the Harvard RoboBee, an insect-scale flapping-wing robot, and HAMR, a bio-inspired crawling robot. Her research looks at the integration of the control system, sensors, and power electronics within the strict weight and power constraints of these vehicles. Her work on the first autonomous flight of a centimeter-scale vehicle was recently featured on the cover of Nature. She is a 2018 Rising Star in EECS, the recipient of a NSF Graduate Research Fellowship, and co-author on the IROS 2015 Best Student Paper for an insect-scale, hybrid aerial-aquatic vehicle. Her work on the RoboBee project can be seen at the Boston Museum of Science, World Economic Forum, London Science Museum, and the Smithsonian, as well as in the popular press (The New York Times, PBS NewsHour, Science Friday, and the BBC). She is interested in the codesign of mechanical and electrical systems for mass-, power-, and computation-constrained robots.

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