Biologically-Inspired Flying Sensor Platform for Autonomous Emergency Response

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Flying robots have tremendous potential for many applications, including search and rescue and emergency response. However, the capabilities of these robots are currently highly limited, and existing flying robot platforms are too large, slow, and expensive for practical use. In this project, I draw from how nature solves the problems of sensing, perception, and navigation to create a small low-cost flying robot platform to help first responders. For example, my robot can be sent into a burning building, avoiding obstacles while using sensory information to quickly locate a target (e.g., the source of the fire, a trapped victim, or a hazardous chemical leak). First, I demonstrate a novel monocular mapping algorithm that maps cluttered environments by taking advantage of the size expansion cues used by many organisms to perceive their surroundings. Second, I present a behavior-based navigation algorithm that mimics the sensory fusion and search maneuvers of fruit flies to locate hazardous chemicals and fires. Both of these algorithms are lightweight and highly efficient; all computation is done onboard on a low-cost embedded processor. On this processor, the mapping algorithm can process 81 frames per second, and is more than three times as fast as the current state-of-the-art. In addition, the navigation algorithm is able to locate targets even in very large spaces within a few minutes, a fraction of the flight time of a typical off-the-shelf quadrotor on a single battery charge.

Awards Won:

Second Award of $2,000

European Organization for Nuclear Research-CERN: Third Award $500