Laser-assisted failure recovery for dielectric elastomer actuators in aerial robots

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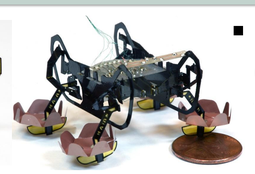
https://www.rle.mit.edu/smrl/research/aerial-robot-powered-by-soft-actuators/

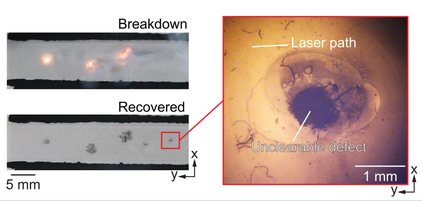
Summary: We aim to develop insect-scale aerial robots that can operate in cluttered environments where the robots may experience frequent collisions and damage. Herein, we present an agile and resilient soft aerial robot that can tolerate severe damage without compromising flight performance.

Key problems and significance

- Existing actuators suffer substantial performance reduction after experiencing damage, which deteriorates flight quality of aerial robots
- Achieving damage resilience in insect-scale robots will enable robust interactions with delicate objects, leading to collective flight in cluttered environments

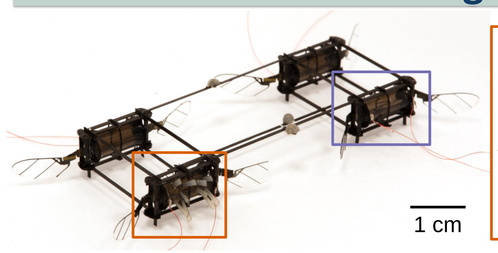
Scientific impact

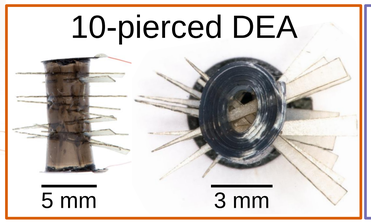


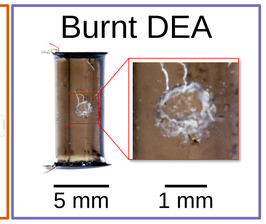


- Provide a unique class of power-dense and damage resilient actuators for mobile (aerial, terrestrial, aquatic, or jumping) robotic systems.
- Benefit dielectric elastomer actuator (DEA) research where device size and lifetime are limited by the presence of defects. Our new laser-assisted approach can isolate defects and recover performance.

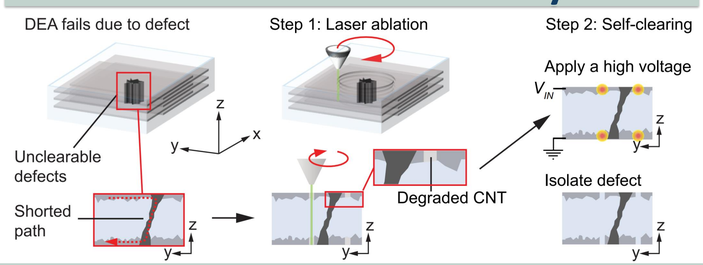
Damaged aerial robot



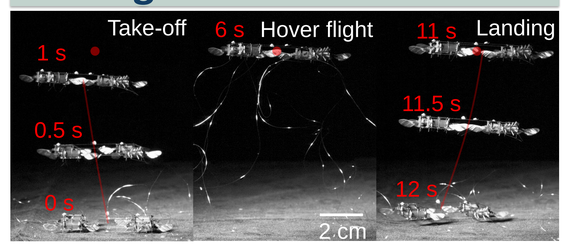




Laser-assisted recovery



Flight demonstration



Potential applications

- Future insect-scale robots will be capable of inspecting the inside of engines, exploring cluttered environments, and pollinating flowers in vertical farming applications
- High-bandwidth DEAs could be used as soft pumps and valves for haptic actuator arrays in VR/AR applications
- Resilient and efficient DEAs could be used to construct medical devices, such as self-propelled capsule robot for endoscopic inspection.

Outreach and education

Educational videos

Museum exhibition

- Educational outreach videos have received over 700,000 views
- Bi-annual lab tours for local K-12 students
- Outreach talk and robot exhibition at the American Museum of Natural History

Publication

Kim, S., Hsiao, Y.H., Lee, Y., Zhu, W., Ren, Z., Niroui, F., and Chen, Y. Laser-assisted failure recovery for robust dielectric elastomer actuators in aerial robots. *Science Robotics.* 8(76), eadf4278 (2023). (Cover article)

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