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Soft-Bodied Aerial Robot

Perching highlights the ability for aerial robots to save energy and maintain a vantage position for monitoring or surveillance. Existing aerial robots coordinate perching mechanisms and flight dynamics to achieve perching. However, there is often a dissociation between controlled collision and dynamic perching in existing designs of aerial robots, as the rigid-body structures are not good at mitigating collision impact incurred during dynamic perching. Also, efforts to address this dissociation have introduced designs that incorporate mechanical impact protection and grasping/perching structures at the cost of reduced agility and flight time due to added weight and bulkiness.

To approach the problem of collision resilience and safe perching, soft robotics has emerged as a promising solution. These soft solutions for perching and grasping, however, are often limited by their load bearing capabilities and slow grasping speeds. There is a need for an aerial robot design that takes into consideration collision resilience, ability to grasp quickly and maintain a grasp, and perch on various shaped and sized perches.

Researchers at Arizona State University (ASU) have developed a soft-bodied aerial robot that effectively absorbs impact force from collisions and contact-based perching and is capable of rapid dynamic perching on various shaped and sized perches. This robot is composed of both contact-reactive perching and embodied impact protection structures while remaining lightweight and streamlined. The robot is capable to 1) pneumatically vary its body stiffness for collision resilience and 2) utilize a hybrid fabric-based, bistable grasper to perform grasping. When compared to conventional rigid drone frames, this robot successfully demonstrates its ability to dissipate impact from head-on collisions and maintain flight stability without any structural damage. Additionally, in dynamic perching scenarios this robot is capable to convert impact energy upon contact into firm grasp through rapid body shape conforming in less than four milliseconds and can retract in less than three milliseconds.

Related publication: A Soft-Bodied Aerial Robot for Collision Resilience and Contact-Reactive Perching

Video of Robot: SoBAR - Demonstrating Contact-Reactive Perching

Potential Applications:

- Aerial robotic design for:
  - Disaster response (e.g., chemical sensing, flood monitoring, wildfire management, etc.)
  - Surveillance (e.g., law enforcement, military, coastal and maritime patrol, traffic monitoring, etc.)

- Search and rescue

Benefits and Advantages:

- Related to collisions, ASU's robot:
  - Can handle high-speed collisions, collision-based perching, and emergency landings
  - Has a collision-safe air frame eliminating the need for a cage-like structure around the robot in applications where no humans are present, thus making the design compact and efficient
- Related to perching, ASU's robot:
  - Absorbs impact energy and uses it to transform the grasper into a continuum closed-form grasping shape in about 4 ms
  - Does not utilize any additional energy to maintain grasp and can pneumatically retract grasp in less than 3 ms