robotics Swiss National Centre of Competence in Research
NEWS BULLETIN
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A foldable antagonistic actuator

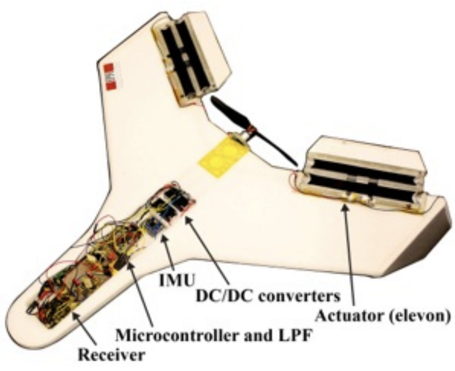
A team from the Laboratory of Intelligent Systems and the Microsystems for Space Technologies Laboratory, both at EPFL, under the umbrella of NCCR Robotics present a new soft actuator used on a fixed wing drone for steering during flight and absorbing the impact of landing. This technology could lead to the future development of fully foldable drones

Using hard actuators requires the development of a complex design and can result in fragility of the finalised structure leading to a loss in functionality. When developing robots for use in cluttered environments such as search and rescue or surveying, these fragilities and lost functions can mean the difference between success or failure of a mission. Recent solutions have used shape memory alloys (SMAs), pneumatic actuators and electroactive polymers – each with their own advantages but also with disadvantages.

The actuator can be completely folded in half without damage

To get around these issues, the team behind the new actuator have come up with a very elegant solution. By placing two stacked or single dielectric elastomer actuators (DEAs) on top of each other in an antagonistic configuration, the result is an actuator that allows bidirectional actuation and passive folding. Each DEA consists of a thin elastomer membrane between two compliant electrodes – the opposing charges on each electrode generate an electrostatic force (Maxwell stress), which squeezes the membrane causing thinning and expansion in the direction of free boundary conditions and therefore results in actuation stretch.

The actuator its self consists of two rigid arms connected via elastic hinges and two sets of DEAs in an antagonistic configuration. When an electric current is applied to one of the DEAs it creates a biased stress between the two DEAs, thus resulting in bending of the actuator. What is particularly exciting about this actuator is that it can literally be bent in half without being damaged in any way.



The actuators were tested on a fixed-wing drone

As a result of this robustness, the team behind the actuator have tested it as an elevon (surface used to control pitch and roll) on a remotely controlled, fixed-wing MAV. The elevons were used successfully for numerous flights, with a launched take off from a hand and a ground landing – landing being a particularly dangerous time of hardware. During flight, the elevon must sustain an angle meaning that the aerodynamic force acts on its surface, again a common reason for failure in flying robots. A good correlation found between the control signal and movement of the robot illustrates the high performance of the actuator.

What is particularly striking about this actuator is how simply it can be designed and made – by using this structure without additional mechanical parts, transmission loss is prevented, and by using a silicon type elastomer a fast response speed and good positioning control can be achieved. Not only fully foldable machines, but also the possibilities for such a compliant actuator are endless – from handling fragile goods in manufacturing to safe human-robot interactions. Future uses may also enable robots to self-deploy without the need for further actuation leading to a generation of robots capable of programmable shape change and reconfiguration.

The full paper by Shintake, J., Rosset, S., Schubert, B. E., Floreano, D. and Shea, H.R. will be published in an upcoming edition of IEEE/ASME Transactions on Mechatronics and can be downloaded ahead of printing here.

Keep up to date with NCCR Robotics

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