robotics Swiss National Centre of Competence in Research

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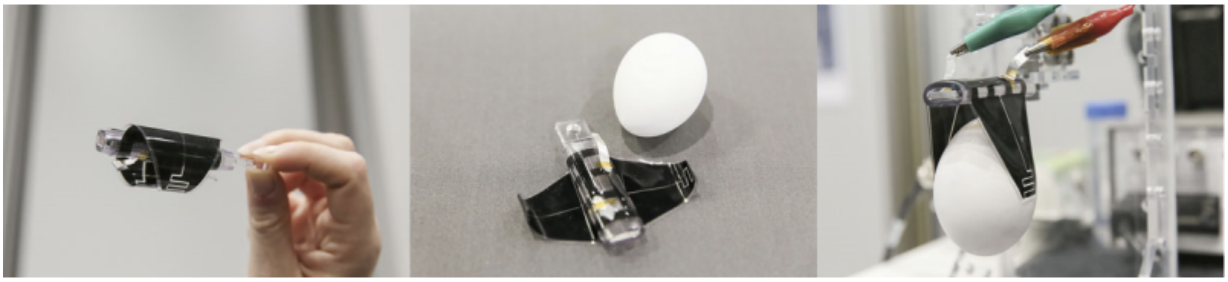
A New Versatile Soft Gripper

From early childhood, when a person picks up an object using their hands they use haptic feedback to automatically adjust the force of their grip according to the object they are lifting. A completely different grip is required when holding a soft piece of fruit and a glass ornament – both very delicate in their own ways – and your body will automatically adjust to the appropriate grip by sensing small shear movements and exploiting the natural compliance of your fingers in the soft, fleshy pads of your finger tips to do so. Equipping robotic grippers with this level of compliance and versatility has long been a problem, but in a paper published in Advanced Materials, a team from LMTS and LIS, EPFL and NCCR Robotics propose a solution that has been used to pick up diverse objects including a raw chicken egg, a water balloon and a flat piece of paper with a simple control input.



While most robotic grippers are designed for the type of object they will pick up, the versatility of this two-fingered gripper comes from its ability to maximise electroadhesion and electrostatic actuation while allowing self-sensing through newly designed bending dielectric elastomer actuators (DEAs). Electroadhesion force alternates the holding force enable it to pick up heavier objects and minimises the need for mechanical grasping force generated by electrostatic actuation, allowing the gripper to handle very fragile and deformable objects in a wide variety of shapes.

The key novelty that allows this new gripper to behave differently is the arrangement of electrodes within the DEA. Traditionally, DEAs function through a thin elastomer membrane sandwiched between two highly compliant, uniform parallel electrodes. When a voltage is applied across the membrane the opposing charges on the electrodes generate electrostatic pressure, which in turn leads to a reduction in thickness and an expansion of the surface area, resulting in bending.

For DEA actuation, electric fields inside the membrane normal to the surface are usually the only ones considered, but they are not the only ones produced: Fringe electrical fields are created at the electrode edge which can bring about electroadhesion in nearby objects.

In order to exploit the electroadhesion and the electrostatic actuation of the DEA, four compliant electrodes are interwoven such that adjacent electrode segments on the same planar surface are orientated with the opposite polarity nearest, thus meaning that when a voltage is applied, the fringe electric fields are experienced across the whole DEA, rather than just at the edges, leading to the electroactuation forces being increased tenfold.

The simple structure of the gripper means that it is lightweight (approx. 1.5g), fast functioning (approx. 100ms to close the fingers), and has a high design flexibility to find potential applications in such diverse places as small transportation drones, the food industry and medical robotics.

VIDEO

References

J. Shintake, S. Rosset, B. Schubert, D. Floreano and H. Shea, "Versatile soft grippers with intrinsic electroadhesion based on multifunctional polymer actuators," Advanced Materials, 2015. doi:10.1002/adma.201504264

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NCCR Robotics

The Swiss National Center of Competence in Robotics (NCCR Robotics) is a federally funded programme bringing together robotics laboratories from EPFL, ETH Zurich, University of Zurich and IDSIA to work on wearable, rescue and educational robots.

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