ROSE: A revolutionary, nature-inspired soft embracing robotic gripper

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ROSE can pick up a wide variety of objects with ease. The top-left image shows it grasping a coffee can, whereas the bottom images show it successfully picking up a peeled chicken egg submerged in olive oil. The image on the right shows the maximum lifting force that ROSE can withstand. Credit: Van Anh Ho from JAIST.

Although grasping objects is a relatively straightforward task for us humans, there is a lot of mechanics involved in this simple task. Picking up an object requires fine control of the fingers, of their positioning, and of the pressure each finger applies, which in turn necessitates intricate sensing capabilities. It's no wonder that robotic grasping and manipulation is a very active research area within the field of robotics.

Today, industrial robotic hands have replaced humans in various complex and hazardous activities, including in restaurants, farms, factories, and manufacturing plants. In general, soft robotic grippers are better suited for tasks in which the objects to be picked up are fragile, such as fruits and vegetables. However, while soft robots are promising as harvesting tools, they usually share a common disadvantage: their price tag. Most soft robotic gripper designs require the intricate assembly of multiple pieces. This drives up development and maintenance costs.

Fortunately, a research team from the Japan Advanced Institute of Technology (JAIST), led by Associate Professor Van Anh Ho, have come up with a groundbreaking solution to these problems. Taking a leaf from nature, they have developed an innovative soft robotic gripper called 'ROSE,' which stands for 'Rotation-based Squeezing Gripper.' Details about ROSE's design, as well as the results of their latest study, have been presented at the Robotics: Science and Systems 2023 (RSS2023) conference.

What makes ROSE so impressive is its design. The soft gripping part has the shape of a cylindrical funnel or sleeve and is connected to a hard circular base, which in turn is attached to the shaft of an actuator. The funnel must be placed over the object meant to be picked up, covering a decent portion of its surface area.

Then, the actuator makes the base turn, which causes the flexible funnel's skin to wrap tightly around the object, as shown in the video below. This mechanism was loosely inspired by the changing shapes of roses, which bloom during the day and close up during the night.

ROSE offers substantial advantages compared to more conventional grippers. First, it is much less expensive to manufacture. The hard parts can all be 3D-printed, whereas the funnel itself can be easily produced using a mold and liquid silicone rubber. This ensures that the design is easily scalable and is suitable for mass production.

Second, ROSE can easily pick up a wide variety of objects without complex control and sensing mechanisms. Unlike grippers that rely on finger-like structures, ROSE's sleeve applies a gentler, more uniform pressure. This makes ROSE better suited for handling fragile produce, such as strawberries and pears, as well as slippery objects. Weighing less than 200 grams, the gripper can achieve an impressive payload-to-weight ratio of 6812%.

Third, ROSE is extremely durable and sturdy. The team showed that it could successfully continue to pick up objects even after 400,000 trials. Moreover, the funnel still works properly in the presence of significant cracks or cuts. "The proposed gripper excels in demanding scenarios, as evidenced by its ability to withstand a severe test in which we cut the funnel into four separate sections at full height," remarks Assoc. Prof. Ho, "This test underscores the gripper's exceptional resilience and optimal performance in challenging conditions."

Finally, ROSE can be endowed with sensing capabilities. The researchers achieved this by placing multiple cameras on top of the circular base, pointing at the inside of the funnel, which was covered in markers, whose position could be picked up by the cameras and analyzed through image processing algorithms. This promising approach allows

for size and shape estimation of the grasped object.

The research team notes that ROSE could be an enticing option for various applications, including harvesting operations and sorting items in factories. It could also find a home in cluttered environments such as farms, professional kitchens, and warehouses.

"The ROSE gripper holds significant potential to revolutionize gripping applications and gain widespread acceptance across various fields," concludes Assoc. Prof. Ho, "Its straightforward yet robust and dependable design is set to inspire researchers and manufacturers to embrace it for a broad variety of gripping tasks in the near future."

More information: Son Tien Bui et al, ROSE: Rotation-based Squeezing Robotic Gripper toward Universal Handling of Objects, *Proceedings of Robotics: Science and Systems* (2023) DOI: 10.15607/RSS.2023.XIX.090.
www.roboticsproceedings.org/rss19/p090.pdf

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