A Soft Robotic Skin with Integrated Optical Sensing and Jamming Mechanism

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Abstract (should be within 1st page)

To enable robots to manipulate objects with capabilities comparable to the human hand, improvements in tactile sensing and grasping performance are essential. In this research, we propose a novel soft robotic skin, combining vision-based sensing and a jamming mechanism, to enhance tactile sensing and grasping abilities. By incorporating transparent beads and transparent oil with an adjusted refractive index, our soft skin achieves high spatial resolution tactile sensing through vision-based methods. Additionally, the control of skin stiffness is achieved by utilizing the jamming transition of the filled transparent beads, enabling effective grasping.

To establish the practicality of our concept, we design and test three robotic devices, namely a gripper, fingertips, and a jig, that utilize the proposed robotic skin. First, we designed a ball-shaped gripper capable of sensing skin deformation and grasping objects through granular jamming. Next, we developed a miniaturized fingertip device. This fingertip device was less than half the size of a ball-type gripper yet functioned correctly for parallel gripper and successfully grasped both fragile objects and heavy objects. Finally, we created a soft jig that ensured object fixation and accurate pose estimation even when its size was doubled from the ball-type gripper.

The results confirm that the proposed skin structure is achievable to enhance tactile sensing and grasping capabilities and can be used as a scalable basic element in robotic applications.