Bending Shape Self-Sensing Pneumatic Grasper: Intelligent Evolution of Soft Robots

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Soft robots, known for flexibility and adaptability, surpass traditional rigid robots in tasks involving delicate objects and confined spaces. However, integrating conventional rigid sensors into soft structures presents a significant challenge due to their potential damage to the robot and incompatibility, which leads to inaccuracy. This project introduces a soft pneumatic grasper with self-shape perception and shape-sensing through a flexible sensing system, marking a significant advance in soft robot intelligence. Employing bionic design principles, the robot's structure was optimized via physical simulation. Stretchable resistive sensors made of liquid metal, responsive to robot deformations, are integrated on the top, middle, and bottom part of the robot fingers, and a mathematical model correlates sensor resistance changes to shape alterations. The curvature output from different sensors from gripping objects with different shapes will be collected and trained under the Multi-classification SVM algorithm, which enables the robot to shape-sensing. A signal amplification circuit is designed to amplify the sensor signals for higher accuracy. The signals will be transported to an Arduino chip, which transmits them to the computer for real-time visualization. The tested error of the mathematic model and the training result of the SVM algorithm both show high accuracy. The project represents a significant step from 0 to 1, from a mere structure to intelligence, improving soft robots' performances in various fields such as intelligent industrial grasper and intelligent soft prosthetics.

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