SCIENCE & TECHNOLOGY

Soft robots gain new strength

Penn Engineers have developed a clutch 63 times stronger than current electroadhesive clutches, making soft robots stronger and safer and making virtual reality gloves feel more real.

Soft robots, or those made with materials like rubber, gels and cloth, have advantages over their harder, heavier counterparts, especially when it comes to tasks that require direct human interaction. Robots that could safely and gently help people with limited mobility grocery shop, prepare meals, get dressed, or even walk would undoubtedly be life-changing.

A robotic arm holding the hand of a mannequin.

In a demonstration, the clutch was able to increase the strength of an elbow joint to be able to support the weight of a mannequin arm at the low energy demand of 125 volts. (Image: Penn Engineering Today)

However, soft robots currently lack the strength needed to perform these sorts of tasks. This long-standing challenge—making soft robots stronger without compromising their ability to gently interact with their environment—has limited the development of these devices.

With the relationship between strength and softness in mind, a team of Penn Engineers (https://www.seas.upenn.edu/) has devised a new electrostatically controlled clutch which enables a soft robotic hand to be able to hold 4 pounds, which is 40 times more than the hand could lift without the clutch. In addition, the ability to perform this task requiring both a soft touch and strength was accomplished with only 125 volts of electricity, a third of the voltage required for current clutches.

Their safe, low-power approach could also enable wearable soft robotic devices that would simulate the sensation of holding a physical object in augmented- and virtual-reality environments.

James Pikul (https://directory.seas.upenn.edu/james-h-pikul/), assistant professor in mechanical engineering and applied mechanics (MEAM) in the School of Engineering and Applied Science (https://www.seas.upenn.edu/), Kevin Turner (https://directory.seas.upenn.edu/kevin-t-turner/), professor and chair of MEAM with a secondary appointment in materials science engineering, and their Ph.D. students, David Levine, Gokulanand Iyer and Daelan Roosa, published a study in *Science Robotics* (https://www.science.org/doi/10.1126/scirobotics.abo2179)describing a new, fracture-mechanics-based model of electroadhesive clutches, a mechanical structure that can control the stiffness of soft robotic materials.

"Our approach tackles the force capacity of clutches at the model level," says Pikul. "And our model, the fracture-mechanics-based model, is unique. Instead of creating parallel plate clutches, we based our design on lap joints and examined where fractures might occur in these joints. The friction model assumes that the stress on the system is uniform, which is not realistic. In reality, stress is concentrated at various points, and our model helps us understand where those points are. The resulting clutch is both stronger and safer as it requires only a third of the voltage compared to traditional clutches."

This story is by Melissa Pappas. Read more at Penn Engineering Today (https://blog.seas.upenn.edu/soft-robots-gain-new-strength-and-make-virtual-reality-gloves-feel-more-real/).

CREDITS	**From Penn Engineering Today** Writer
DATE	**December 7, 2022**
SUBTOPICS	**Robotics**
SCHOOLS	**School of Engineering & Applied Science**