Picking and Placing with Flexible Fingers

Joseph L. Hazelton, Contributing Editor

They're like real fingers, able to pick up hard stuff, a spark plug or a metal pipe connector, and pick up soft stuff without breaking or smushing it: an egg, a loaf of bread, a donut.

Oftentimes, they pick up these things using one program that's changed by resetting two variables: amount the fingers open and strength of their grip.

And imagine, this pick-and-place system started a few years ago as a research project at Harvard University, Cambridge, MA. Since then, it's been improved for use in industry. Today, the fingers are used in industries like manufacturing, e-commerce and retail, and food and beverage; and they're made by Soft Robotics Inc., Bedford, MA.

To understand how the fingers work, imagine a balloon, the kind you twist into animal shapes. Filled with air and held in your hands, the balloon is a long, thin tube, with one end in your left hand and one end in your right.

Now, imagine the balloon isn't made of latex. Imagine it's made of two materials, one for the balloon's top half, one for its bottom half. And imagine the top half is made of softer, more flexible material than the bottom half.

So, when this balloon fills with air, it won't inflate uniformly. The softer material will inflate more than the harder one, so much more it'll make the harder material curl.

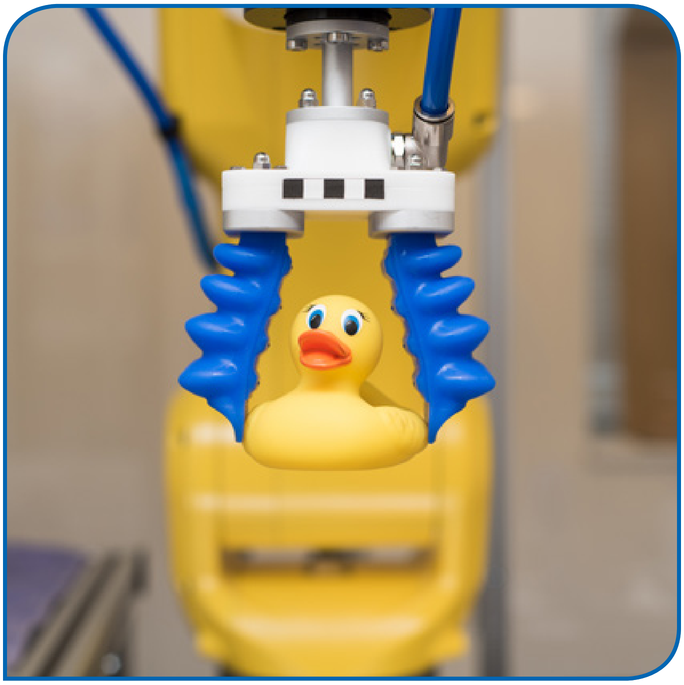
So that the bottom curls as much as a finger, the top needs excess material. To imagine the excess, look at your own finger, at the knuckles. They have excess skin. When your finger is straight, the excess folds, making small ridges. Bend your finger, and the excess unfolds.

Now, look at the blue fingers in the photo above. Each finger has excess material, the accordion-style folds. So, when a finger fills with air, the accordion half expands fast, its folds smooth out, and the other half curls. Just like a finger.

Besides flexible fingers, there's also an adjustable "palm." It's a metal hub and plastic spacers. There are actually two kinds of hubs, a circular one and a parallel one.

Of course, with a circular hub, the fingers are in a circle. That makes it easier to pick up some things: a strawberry or a donut. With a parallel hub, the fingers are in two parallel rows. Each finger has an opposite across the hub. So, a hub with six fingers has two rows of three fingers each. That way, the fingers can hold longer things, like an IV bag or a coffee bag. With the plastic spacers, the palm can be resized as needed.

Now, to move the fingers, there's an electropneumatic control system. It attaches to a robot arm and is attached to a company's air tank on its shop floor.



Actuated by air, these blue fingers bend like real fingers and can pick up things different in size, shape, weight, and firmness. Two fingers can pick up a rubber ducky; six can pick up a 13-pound bag of laundry detergent. (Photo courtesy of Soft Robotics Inc.)

This system is controlled by desktop software. On a computer screen, the program has two slider bars, one to control how much the fingers spread apart, the other to control the fingers' grip strength. Both settings make up a grip profile, and the system can store up to eight of them.

Oftentimes, though, the system doesn't need different profiles to work. One profile may be enough for many things different in size, shape, weight, and firmness.

"The system is so adaptable, we don't use the profiles that much," says Carl Vause, CEO of Soft Robotics. "For the majority of applications, we use a single grip profile."

But, when picking up different things, a protein bar and a loaf of bread, how does the system stop? How does it know its grip is secure and it doesn't have to squeeze any harder?

It knows because of a natural phenomenon, which Vause explains.

Filling with air, the fingers bend, wrapping around their object. At some point, the force they're exerting will match the force exerted by the object: equilibrium. Air pressure will stop accumulating, the pressure achieved will hold steady, and the robot arm will lift and move the object.

"We rely on that phenomenon to grip things without sensors," Vause says, "and do it across these wide ranges of objects without damaging them." **PTE**