Engineers bring a soft touch to commercial robotics

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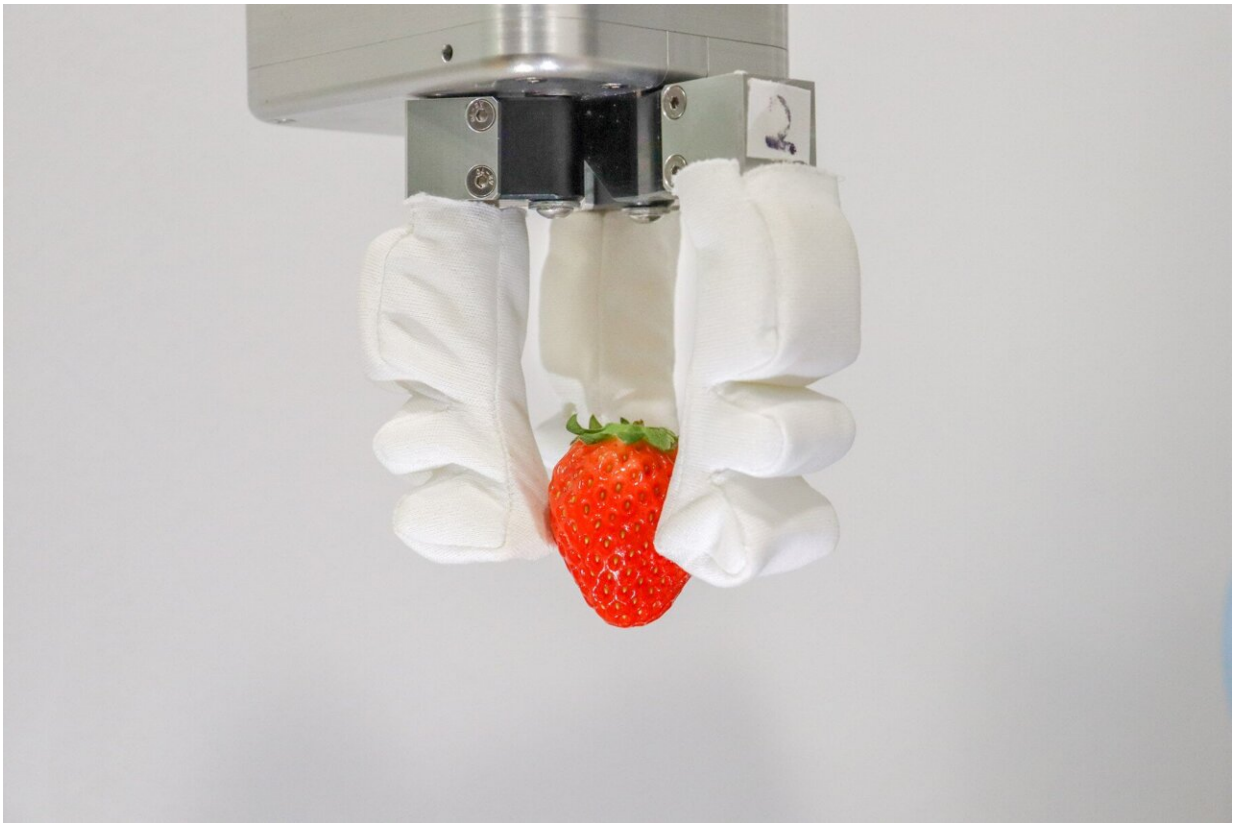


Inspired by the dexterity of a human hand, the NUS team has developed a hybrid robotic gripper which can be reconfigured on demand to pick and place a wide range of delicate food items. Credit: National University of Singapore

Inspired by the natural dexterity of the human hand, a team of engineers

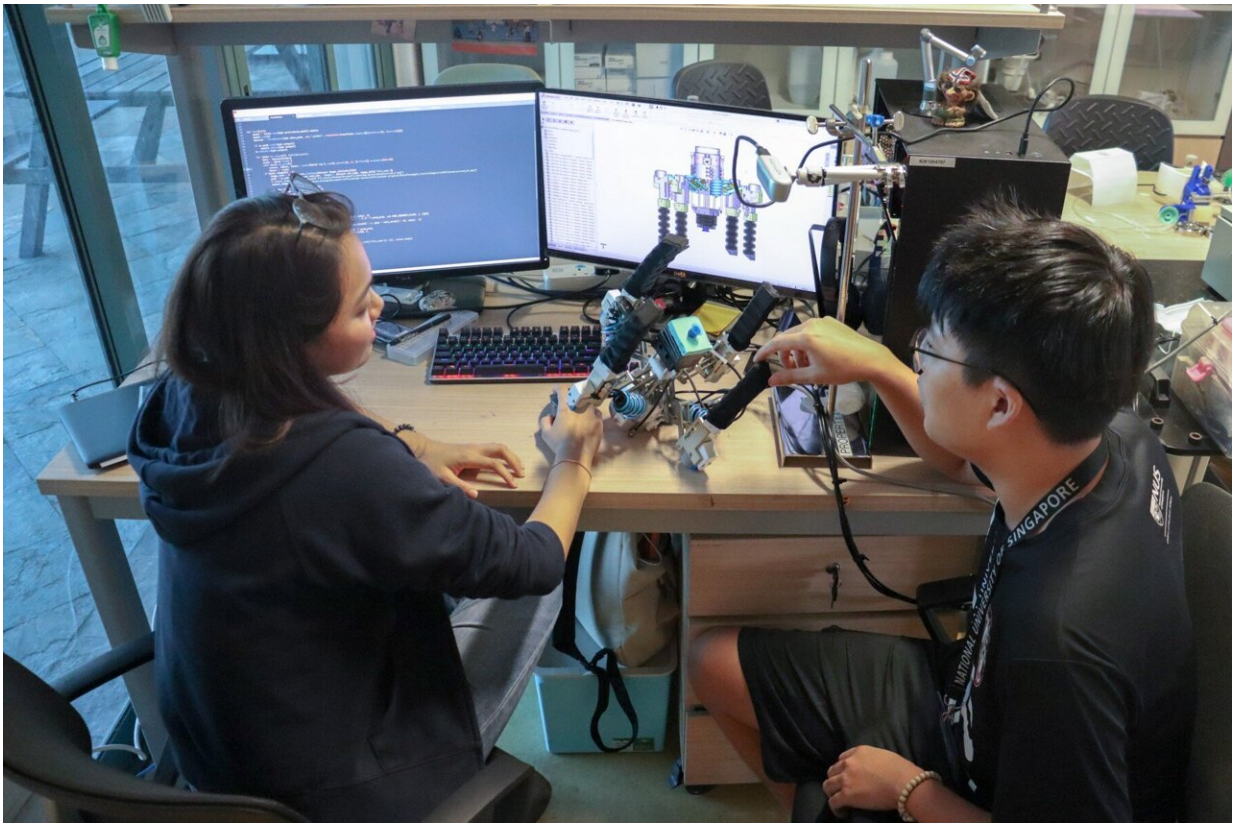
from the National University of Singapore (NUS) has created a reconfigurable hybrid robotics system that is able to grip a variety of objects: from the small, soft and delicate to the large, heavy and bulky. This technology is expected to impact a range of industries, involving food assembly, vertical farming and fast-moving consumer goods packaging, which will progressively automate more of their operations in the coming years.

Led by Associate Professor Raye Yeow from the NUS Department of Biomedical Engineering and the NUS Advanced Robotics Centre, the hybrid robotic grippers use soft, flexible 3D-printed fingers with a reconfigurable gripper base. The robotic innovation is now in the process of being brought to commercial partners under the team's start-up RoPlus (RO+), comprising NUS researchers Low Jin Huat, Khin Phone May, Chen Chao-Yu and undergraduate student Han Qian Qian.

"An object's shape, texture, weight and size affect how we choose to grip them. This is one of the main reasons why many industries still heavily rely on human labor to package and handle delicate items," Assoc Prof Yeow said. "Our hybrid robotic gripper technology revolutionizes traditional pick-and-place tasks by offering advanced capabilities that allow robots to safely interact with delicate items of various shapes, sizes and stiffness, just like the human hand."

Bio-inspired gripping solutions

Gripping is one of the most common and natural tasks that people perform, but for robots, it is not as intuitive. To achieve human-like gripping abilities, robots need computer vision and deep learning to detect the type of objects in front of them as well as their orientation. The gripper can then automatically decide on how best to pick and place objects to minimize the necessity of intensive human intervention.



The 3D-printing method used to produce the soft robotic grippers is low-cost and offers flexibility in customising the actuator design, based on actual gripping requirements. Credit: National University of Singapore

With the aim of developing robotic grippers that are as dexterous as human hands, the NUS team came up with hybrid robotic grippers, consisting of three or four soft fingers, which can reconfigure on demand. The fingers are air-driven and equipped with a novel locking mechanism for adjustable stiffness. The NUS team has developed three types of hybrid robotic gripper systems—almost like three different hands that are useful in different contexts.

The first is GourmetGrip, which is suitable for the most granular tasks

like handling delicate bite-sized snacks, or food easily prone to damage like tofu, and packs them into take-out boxes. This soft-handed mode is reconfigurable so that it can accommodate different grip poses as well as a variety of space restrictions. When mounted on an industrial robotic arm, GourmetGrip can achieve pick-and-place of food items at a speed comparable to that of a human, and it can perform these tasks at a consistent pace round the clock. When benchmarked against other commercially available grippers, the GourmetGrip system is able to deliver about 23 percent improvement in gripping efficiency, with the ability to hold items faster and more precisely. To date, the GourmetGrip system can effectively pick up more than 50 different food items such as pudding, sliced cake, vegetables and fruits.

The second type of gripper is known as UnisoGrip, or Universal Soft Gripper, which is the team's more widely applicable solution. It is designed for handling packaged goods along the assembly line when they are usually at the final stage of being placed into boxes for shipping and transportation. It is capable of substantially expanding its grip range, and has soft rotatable gripper fingers for delicate grasping, as well as a vacuum suction cup that allows it to move more awkwardly positioned objects such as the corner of a tote bin.

Unlike GourmetGrip, which has a grip range similar to a human hand, the UnisoGrip is significantly larger and can handle items that are up to 30 centimeters wide and weigh up to three kilograms, so it is more versatile in handling a large variety of consumer goods. It also has a 20 percent higher gripping efficiency than other commercially available grippers. To date, the UnisoGrip system can pick up over 30 different types of consumer goods such as bottled drinks, coffee powder packs, refillable detergent packs, and more.

The third type of gripper is one that is fully customisable, based on the GourmetGrip/UnisoGrip platforms, to adapt to specific client needs and

space constraints. This approach offers a wide variety of gripping options that can handle objects of different shapes, sizes and packaging materials. The NUS team's customisable technology has been deployed at People Bee Hoon Factory, a Singapore-based rice vermicelli manufacturer, for optimizing the packing of rice vermicelli packets into carton boxes.

Commenting on the company's decision to invest in the NUS technology, Mr Desmond Goh, Director of People Bee Hoon Factory said, "Most of our existing staff are mature workers, so we sought to tap on new technology that can ease the workload of our existing staff, while simultaneously boosting their productivity. We selected this technology because it is able to meet our purpose, and provides flexibility for different deployments that we require."

Provided by National University of Singapore