Gecko grippers get a microgravity test flight (w/ Video)

December 22 2014, by Elizabeth Landau

This is an image of a gecko foot. Researchers at NASA's Jet Propulsion Laboratory have developed a gripping system based on the way that gecko feet are able to stick to surfaces. Just as a gecko's foot has tiny adhesive hairs, the

JPL devices have small structures that work in similar ways. Image credit: Wikimedia Commons

There are no garbage trucks equipped to leave the atmosphere and pick up debris floating around the Earth. But what if we could send a robot to do the job?

Scientists at NASA's Jet Propulsion Laboratory in Pasadena, California, are working on adhesive gripping tools that could grapple objects such as orbital debris or defunct satellites that would otherwise be hard to handle.

The gecko gripper project was selected for a test flight through the Flight Opportunities Program of NASA's Space Technology Mission Directorate. As a test, researchers used the grippers in brief periods of weightlessness aboard NASA's C-9B parabolic flight aircraft in August.

"Orbital debris is a serious risk to spacecraft, including the International Space Station," said Aaron Parness, a JPL robotics researcher who is the principal investigator for the grippers. "This is definitely a problem we're going to have to deal with. Our system might one day contribute to a solution."

The gripping system developed by Parness and colleagues was inspired by geckos, lizards that cling to walls with ease. Geckos' feet have branching arrays of tiny hairs, the smallest of which are hundreds of times thinner than a human hair. This system of hairs can conform to a rough surface without a lot of force. Although researchers cannot make a perfect replica of the gecko foot, they have put "hair" structures on the adhesive pads of the grippers.

The synthetic hairs, also called stalks, are wedge-shaped and have a slanted, mushroom-shaped cap. When the gripping pad lightly touches part of an object, only the very tips of the hairs make contact with that surface.

"The stickiness of the grippers can be turned on and off, by changing the direction in which you pull the hairs," Parness said.

To get the gripper to stick to a surface, force is applied to the adhesive pad material in a manner that makes the hairs bend. This increases the real area of contact between the hairs and the surface, which corresponds to greater adhesion. When the force is relaxed and the hairs go back to being upright, this process turns off the stickiness.

A phenomenon called van der Waals forces, named for Nobel Prize-winning physicist Johannes Diderik van der Waals, explains the non-permanent stickiness of the grippers, as well as gecko feet. These temporary adhesive forces happen because electrons orbiting the nuclei of atoms are not evenly spaced, creating a slight electrical charge. Such forces persist even in extreme temperature, pressure and radiation conditions.

"The reliability of van der Waals forces, even in severe environments, makes them particularly useful for space applications," Parness said.

"The system could grapple objects in space that are spinning or tumbling, and would otherwise be hard to target," he said.

In the recent tests, the grippers were able to grapple a 20-pound cube as it floated. The grippers also were able to grapple a researcher wearing a vest made of spacecraft material panels, representing a 250-pound "object." Members of the research team held the device with adhesive pads during the test, but the eventual idea is to integrate the grippers into

a robotic arm or leg.

In total, the grippers have been tested on more than 30 spacecraft surfaces at JPL. They also have been tested successfully in a JPL thermal vacuum chamber, with total vacuum conditions and temperatures of minus 76 degrees Fahrenheit (minus 60 degrees Celsius) to simulate the conditions of space. While Parness was in graduate school at Stanford University in Palo Alto, California, the grippers were tested separately in more than 30,000 cycles of "on" and "off," with the adhesive staying strong. Several prototypes have since been designed.

There are more than 21,000 pieces of orbital debris larger than 3.9 inches (10 centimeters) in Earth's orbit. The U.S. Space Surveillance Network routinely tracks these objects. In 2009, an accidental collision occurred between an operational communications satellite and a large piece of debris, destroying the satellite.

Besides grappling orbital debris, the grippers could help inspect spacecraft or assist small satellites in docking to the International Space Station. The grippers are another example of how technology drives exploration.

Provided by NASA