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PRESS RELEASE

Release Title:

Inspired by a soft body of a leech – a wall-climbing robot

Release Subtitle:

180 degree rotation from one side of the wall to the other

Abstract

A research team led by Associate Prof. Tomoaki Mashimo at Toyohashi University of Technology has successfully developed a leech-shaped robot, “LEeCH”, which can climb vertical wall. LEeCH is capable of elongate and bend its body without any constraints; just like a leech. Thanks to its flexible body structure and the suction cups, the robot has successfully climbed a vertical wall and even reached to the other side of the wall.

Contents

A research team of Dr. Tomoaki Mashimo, Associate Prof. of Department of Mechanical Engineering at Toyohashi University of Technology, and Dr. Fumiya Iida, a reader in robotics of the department of Engineering at the University of Cambridge, has successfully developed a leech-shaped robot, “LEeCH”, which can climb vertical wall. LEeCH（Longitudinally Extensible Continuum-robot inspired by Hirudinea, with a flexible body, made of a material used for shower hose, and two suction cups, is capable of elongate and bend its body without any constraints; just like a leech. Thanks to its flexible body structure and the suction cups, the robot has successfully climbed a vertical wall and even reached to the other side of the wall. The study was published in Soft Robotics, an American scientific journal, on March 27 2019.

Wall climbing robots have a wide range of potential application, including building inspection and maintenance, and search and rescue tasks at disaster sites. Climbing straight up vertical walls is fairly easy to accomplish, however, in reality, the robot may have to navigate over obstacles on the wall such as steps and transition to walls with different directions. The hardest task is to reach the other side of the wall. A robot capable of climbing up to the top of the wall has to face extreme difficulty in traversing the summit over to the other side.

The team has developed a robot inspired by land leeches, which are excellent climbers in nature. The land leeches, usually found in forests or mountains, can move around complex terrain and walls using two suction cups on both ends of bodies and soft extensible bodies. Their bodies are so light and soft that they are not subject to great damage from a fall from height.

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The team designed a new motion mechanism using tube structure of shower hose to mimic the advantageous properties of leeches, namely, lightweight, flexible and extensible. The flexible tube with a metal plate with S shaped profile spirally wound has been used in general households. A gear engages with the helical groove on the surface of the tube. The flexible tube moves back and forth by the rotational motion. The robot has a body composed of three flexible tubes that are connected in parallel. The body can bend or elongate by controlling the length of each flexible tube fed by the gear.

The robot successfully achieved upward/downward climbing and horizontal transition on a vertical wall. By combining these two transitions, the robot is capable of moving freely on a two-dimensional wall surface. The robot's flexible body with large deformation enabled it to transition from one side of a vertical wall to the other side. This is the world's first achievement in developing soft and flexible robot that is capable of free movement on a wall.

The person in charge of the development and the lead author of the study, Ayato Kanada, Doctoral Programs student, says "I came up with the idea in the bathroom of my house. The shower hose went wild as if it had a life when I inadvertently turned on the faucet at maximum. Then an idea occurred to me that if I could manipulate a hose, I might be able to make a robot with dynamic movement of living creature".

Making the most of the hollow structure of the shower hose, the team is considering the possibility of changing stiffness of the tube by pouring fluid into the cavity. Robot with flexible body structure is not only highly adaptable to environment, but also highly secure against collision. It has a potential application to labor in proximity to humans.

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Reference:

Ayato Kanada, Fabio Giardina, Toby Howison, Tomoaki Mashimo, Fumiya Iida, "Reachability Improvement of a Climbing Robot based on Large Deformations induced by Tri-Tube Soft Actuators," Soft Robotics.
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Website: https://www.tut.ac.jp/english/

Movie:
https://www.youtube.com/watch?v=uCISNjwTLgU
Title: Experiment video of wall-climbing robot
Caption: Four types of walking on vertical wall

Figure:

(a) (b)

Title: Schematic of proposed climbing robot.
Caption: chematic of proposed climbing robot. (a) Real leech. (b) LEeCH (Longitudinally Extensible Continuum-robot inspired by Hirudinea).

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