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A LUNAR SURFACE MULTI-MODE LOCOMOTION SOFT ROBOT BASED ON ASYMMETRIC DESIGN

Abstract

In the coming decade, the continuous advancement of lunar exploration projects will significantly reshape the global scientific, technological, and economic landscapes. Lunar surface robotic operations, being safer, more efficient, and less costly than human space missions, are crucial tools for human lunar exploration.Compared with traditional rigid lunar surface robots, soft robots have excellent adaptability to the lunar environment, safe interaction capabilities, and strong development potential, thus attracting extensive social attention. However, they suffer from low response speeds and small output forces, resulting in a single crawling movement mode and inability to handle complex lunar terrains.Inspired by cheetah spine bending and inchworm crawling, and considering the low - gravity lunar environment and terrain obstacles, we developed a multi - mode locomotion bionic pneumatic soft robot for the lunar surface. Its main structure is a closed elastomer composed of a pre-bent elastic strip and two soft pneumatic bending actuators.To enhance its crawling and jumping performance, this paper combines rubber band elasticity with the mechanism's good energy - storage properties. An asymmetric closed elastomer with a passive and an active rotary joint is designed. This configuration can store and release more energy, enabling more powerful jumps compared to the symmetric one through more complex deformations.By applying rubber bands and the asymmetric closed elastomer to the multi - mode mobile pneumatic soft robot and testing its motion performance on a lunar - surface - environment simulation platform, the robot achieves a crawling step length of 30 mm (about 0.18 times its body length), three times that before improvement, and a theoretical jump height of 1200 mm on the lunar surface(about 7.06 times its body length), twice the height before improvement. The experimental results demonstrate that the asymmetric design endows the lunar - surface multi - modal locomotion soft robot with excellent kinematic performance, showing great potential in future lunar exploration, lunar - surface base construction, and other application fields.