The Design of Biomimetic Spherical Robot with Multi-Motion Modes for Space Exploration

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Overview

With the advancement of human exploration of extraterrestrial planets, there is a growing demand for planetary exploration robots that possess high adaptability to surface environments, strong obstacle-crossing capabilities, and long lifespan. Currently, most planetary exploration robots utilize wheeled or rover-like structures, which suffer from limitations such as low maneuverability, large spatial footprint, high launch costs, high energy consumption, and relatively short lifespan. In contrast, spherical robots, with their enclosed internal structure, offer advantages such as extended lifespan, enhanced maneuverability, and robust collision resistance, effectively addressing the deficiencies of conventional planetary exploration robots.

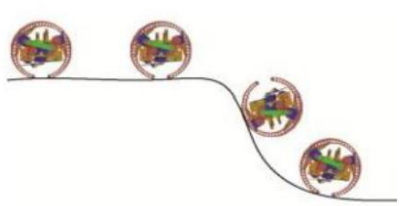
My objective is to design a multi-modal spherical robot based on a bionic structure. This innovative robot capitalizes on the spherical robot's high compression bearing capacity and its ability to autonomously navigate on flat surfaces. Additionally, it incorporates the capability to adapt to rugged terrains and overcome obstacles through self-mode adjustment, creating an adaptive robot capable of switching between different operating modes in diverse environments.

The Biomimetic Spherical Robot with Multi-Motion Modes for Space Exploration

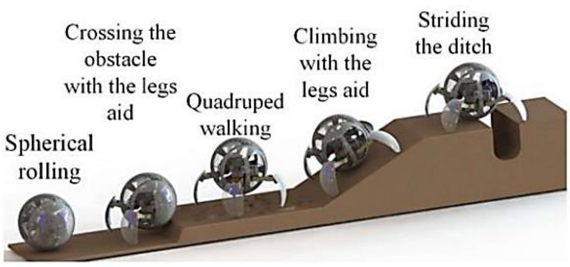
In order to better combine the advantages of hexapod robot and spherical robot, I designed a biomimetic spherical robot with multi-motion modes. Its configuration design is based on the modular design idea and the principle of bionics, and the robot is divided into two modes: hexapod mode crawling motion and spherical mode rolling motion. The hexapod mode is similar to spiders and other reptiles, and the spherical mode is driven by the legs on its sides. In the spherical mode, the hexapod retracted the interior of the body, and the driving force was provided by the two legs extending out from the middle of the body on both sides.

Key-Features

In the rolling mode of the robot, there are two situations: opening side legs and not opening side legs. When the side leg is opened, the side leg can periodically touch the ground to exert a reaction force on the spherical mode robot so that the robot in the spherical state can roll continuously. In the other case, the robot curled up completely into a ball and rolled passively depending only on the terrain it was on. This mode is suitable for flat terrain or downhill.



In the robot's crawling mode, the robot switches to hexapod mode to climb over the obstacle using leg movements. This mode is mainly used for climbing and rough road travel.



Conclusion

The surface topography of the planet is uncertain and complex, including slopes, obstacles, soft pavement, gullies, and rough and uneven terrain. The use of a spherical or hexapod robot for detection has limitations, but the use of spherical robot with multi-motion modes can combine the advantages of spherical and tradition hexapod robots, and use the mode transformation function to make the robot have dual-modal characteristics (spherical mode and hexapod mode), which can not only use the spherical structure to protect the body parts and move quickly on the flat terrain. In addition, it can use the foot structure to achieve the crossing of obstacles on the rugged terrain and realize the change of movement mode by controlling the change of mode, so that the robot can make modal changes according to different surface environments of the planet in the normal process of traveling to adapt to different terrain environments.