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Small Bodies Missions and Technologies (Part 1) (4A)

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SMOOTH LOCOMOTION AND ADHESION CONTROL FOR A HEXAPOD ROVER OF LOW-GRAVITY CELESTIAL BODIES

Abstract

Using robots to conduct mobile exploration activities on small celestial bodies can effectively improve the flexibility of exploration tasks and achieve the goal of close-range and large-scale exploration of celestial bodies. However, due to the constraints of the low gravity environment and complex surface characteristics of small celestial bodies, there are great challenges in robot locomotion control. Based a hexapod robot platform, we propose a six-legged locomotion control method suitable for small celestial bodies. The motion system of the hexapod robot mainly consists of 6 legs with 3 degrees of freedom each, and has the ability to move with static stability, that is, it can achieve stable stance using 3 legs during movement. By utilizing the static stability movement characteristics of the hexapod robot, two aspects of research are conducted to solve the locomotion control problem. First, a smooth design for the gait of the hexapod robot is carried out to reduce the risk of the robot escaping from the surface of the small celestial body during movement. The foot trajectory of the robot is initially planned using a triangular gait, which can be used to determine the swing and stance phases of the robot's six legs. Sequentially, a smooth design based on trigonometric curve is carried out for the foot trajectory in the swing state, so that the joints do not experience significant impact, especially achieving zero-impact lifting and landing when the leg is swinging and landing.Then, taking advantage of the static stability of the hexapod robot, the standing configuration of three supporting legs is designed to form a gripping state. During one gait cycle, the robot needs to synchronize and coordinate between the gripping and swinging states of the three standing legs to achieve stable attachment to the surface of the low-gravity celestial body. Compared with robots that move in the form of rolling or jumping, the crawling form makes the robot's movement more flexible and allows for more precise locomotion control. It is one of the effective ways for surface mobility on small celestial bodies.