Spherical Mobile Robot for Asteroid Exploration and Defense

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ABSTRACT

The detection of asteroid surface characteristics and physical properties is of great significance for human beings to carry out asteroid defense and resource utilization. Mobile robots with relevant payloads are effective means of asteroid surface exploration. However, it is difficult for wheeled or tracked mobile robots to attach and move on the surface of asteroids because of microgravity and unknown terrain. This paper proposes a spherical mobile asteroid robot (SMART) for asteroid exploration and defense. SMART adopts a spherical structure with 8 fixed leg supports. The symmetrical structure design is beneficial to omnidirectional movement and improve the detection accuracy. The movement of the SMART depends on three orthogonally distributed reaction flywheels. Through the torque vector control of the flywheels, the omnidirectional attitude roll movement of the robot is realized, which effectively solves the problem of microgravity. The payloads deployed on SAMRT include multispectral cameras, APXS, lidar, inertial sensors and multiple visible light cameras. The goals of the SAMRT include on-site exploration of the asteroid surface composition and physical properties, the construction of the asteroid local map, and the inversion of the asteroid surface gravitational field. The detailed design, functions and the control method of SMART are provided in the paper. The design and the control method are validated on an equivalent prototype demonstration system.