SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration (5)

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A NOVEL AEROBOT WITH A HEAT ENGINE UTILIZING ATMOSPHERIC TEMPERATURE GRADIENT FOR PLANETARY EXPLORATION

Abstract

Most planets and some moons, such as Earth, Venus, Mars and Titan, inside our solar system have atmospheres. An aerobot can fly in a planet atmosphere by filling with a lifting gas to provide buoyancy. As a potential tool for planetary exploration, aerobots can provide high resolution observation data at a regional scale, compared to land-based rovers/landers and space-based orbiters. The land, aerial and space-based vehicles should be used in conjunction to provide a complete set of capabilities for planetary exploration. One of the main obstacles for planetary exploration is the continuous energy supply for the onboard equipment and exploration payloads. Batteries have been used in a Venus exploration for a very short mission. The solar energy cannot be used during a long planetary night. And the costly nuclear energy (RTG) can only provide limited power (several watts to hundreds watts) and should face nuclear safety problems. A novel aerobot with a heat engine utilizing atmospheric temperature gradient, which is formed by the combined action of the solar radiation and the planetary surface heat radiation, is proposed in this paper. The heat engine absorbs heat from the warm low altitude atmosphere and dissipates heat to the cool high altitude atmosphere during the altitude oscillation of the aerobot, which forms an equivalent thermodynamic cycle to generate power. The working fluid selected for the heat engine is also served as the lifting gas of the aerobot. A design example for Venus exploration is described in detail and its working principles are analyzed. Since the planetary atmosphere can be seemed as a massive energy source, the proposed novel aerobot can provide continuous power to the vehicle equipments for a long-term mission, which should improve future deep space exploration capabilities.