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COLLISION AVOIDANCE CONTROL FOR ASTEROID LANDING BASED ON REINFORCEMENT LEARNING

Abstract

For the problem of autonomous and safe landing on irregularly shaped asteroids, a collision-free feedback control method based on reinforcement learning is proposed. In this paper, the combination of the external ellipsoid constraint and the glide-slope constraint are used to avoid the collision during landing. Due to that reinforcement learning performer well in the environment which has no exactly model, a virtual asteroid is used in the training environment and spherical harmonics with uncertainties is used for the asteroid gravity model. The inputs of the reinforcement learning control method are defended as the combination of relative distance between lander and lander spot and the glide-slope angle of the lander. The outputs of the reinforcement learning control method are defended as accelerations of the lander in the asteroid body-fixed frame. In order to reduce the training time, the ZEM/ZEV control method is used to initialize the network of reinforcement learning. However, the ZEM/ZEV control method cannot handle the collision avoidance situation. Reinforcement learning offsets that disadvantage. The training algorithm is PPO and the training times is set as 5 million. Monte-Carlo simulations is conducted to test landing success rate of the proposed method. The proposed method is applied to the scenarios of landing on asteroids 101955 Bennu and 433 Eros. The simulation results indicate that this method can achieve anti-collision landing in real time.