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AUTONOMOUS SPACE DEBRIS CAPTURING USING DEEP REINFORCEMENT LEARNING METHOD

Abstract

Space debris is considered as a serious problem for operational space missions, effective measures to remove it are becoming urgent. Many enabling space debris capturing methods have been proposed in the past decade and several methods have been tested on ground and/or in parabolic flight experiments. However, the existing methods for controlling of spacecraft to capture space debris are generally through the task-specific algorithm or remotely controlled by ground-based mission operations, usually one method can only be used for one debris removal mission, which obviously lacks intelligence and versatility. While artificial intelligence technology represented by the deep reinforcement learning method has made breakthroughs in many fields, such as playing go, or FPS games, have demonstrated higher intelligence even than human in such fields. Therefore, using artificial intelligence technology to autonomously capture space debris is a promising direction for the development of active debris removal method. In this paper, we proposed a spacecraft control method using deep reinforcement learning method to autonomously capture space debris through the sensors mounted on the spacecraft. Concretely, a three-dimensional space debris removal simulation experiment environment is established. An intelligent agent which controls a chaser satellite to capture the debris is trained in this simulation experiment environment. A deep convolutional neural network is built as the brain of the intelligent agent to control the chaser satellite. The policy gradient method is employed to train the convolutional neural network in an autonomous way, that is the intelligent agent is allowed to try to control the chaser satellite to capture the debris by itself. The intelligent and autonomy space debris capturing is realized through such continuous self-learning and self-evolution. The proposed deep reinforcement learning based active space debris capturing method is not only cutting-edge research in artificial intelligence, but also an innovative application of artificial intelligence technology in space debris removal field. The proposed method uses artificial intelligence technology to achieve intelligent and autonomous space debris capturing, the research results will have a strong application prospects in the future space exploration.