IAF SPACE OPERATIONS SYMPOSIUM (B6)
Interactive Presentations - IAF SPACE OPERATIONS SYMPOSIUM (IP)

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SPACE TARGET POSE ESTIMATION FRAMEWORK WITH DEEP REINFORCEMENT LEARNING TECHNIQUE

Abstract

Vision-based relative navigation technology is the key technology to complete on orbit service, space debris removal, and formation flight. One of the current challenges to this technology is to estimate the attitude of uncooperative targets that do not provide any navigation assistance. Previously, the development of vision-based relative navigation technology has mostly relied on image processing and template matching techniques, such as feature-based matching and tracking methods, based on PnP or PnL methods. In recent years, with the rapid development of deep neural network technology, many scholars began to study how to use CNN and other image recognition networks such as HRnet and GAN for pose estimation of space targets, and the combination of deep learning and traditional PNP method has shown good performance. Although the above methods have achieved good results, the demand for a large training set is not a small cost. This paper focuses on another branch of artificial intelligence: reinforcement learning. Reinforcement learning is an unsupervised learning method, which establishes a set of reward mechanisms, and learns the optimal strategy from the reward or punishment obtained from random and continuous attempts, to maximize the long-term cumulative return. Since feature points are easy to be lost by illumination and noise, linear features have richer attributes and more stable matching, PnL problem has been getting more attention. When the corresponding relationship between the model lines and the image projection lines is known, the relative pose of the target can be solved by least-square or maximum likelihood estimation. When the matching relationship between lines is unknown, this problem is difficult to solve. This paper explores a pose estimation framework that uses deep reinforcement learning to learn the matching relationship and relative pose. The Deep Deterministic Policy Gradient (DDPG) algorithm is adopted since it supports the continuous action space and continuous status space. In the simulation, MDP is carefully designed with the rotation angle being included in the action space. Through continuous attempts and exploration, the model eventually reaches the "correct" posture, and minimizes the distance between the matching model projected lines and image lines. Keywords: pose estimation; Deep Reinforcement Learning;DDPG