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KNOWLEDGE GRAPH BASED SATELLITE COMPONENT DETECTION METHOD FOR ON-ORBIT REFUELING

Abstract

On-orbit refueling is an important on-orbit service (OOS) that plays a key role in extending the effective working life and improving the economic benefits of satellites. In order to achieve on-orbit refueling, the service satellite must poccess a series of on-orbit service technologies, of which the short-range manipulation technology is based on the space rendezvous and docking. The short-range manipulation technology faces practical problems such as unstructured environment, complicated tasks, high requirements of refinement and real-time. To solve the above problems, the design scheme of traditional control methods is complex, and the newly developed reinforcement learning method shows great potential with stronger adaptability. In the reinforcement learning method, it is necessary to first use a camera or laser device to collect the image of the current scene, and use deep learning methods to extract features from the collected image, which affects the success rate and accuracy of reinforcement learning. Although the convolutional neural network has achieved some good results in object detection and segmentation, it lacks logical reasoning capabilities and usually relies on huge training samples. On the other hand, the components on the satellite board are rigid bodies with a certain arrangement relation. Therefore, this paper develops the framework of adding knowledge graph to the traditional object detection and segmentation neural network. As a priori knowledge, knowledge graph introduces the relations between different components and gives neural network reasoning capabilities. We evaluate the proposed method in a physical experiment system to detect components such as the refueling port, docking ring, and engine on the satellite board, and apply it to do feature extraction for reinforcement learning. The results indicate that the method proposed in this paper significantly improves the accuracy of target detection, autonomously detects the target that meets the requirements in the case where multiple similar targets exist at the same time, and without estimating the target pose, it can provide feature input for reinforcement learning, simplifying the process of traditional visual perception in space manipulation.