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A NOVEL METHOD OF SPACE NON-COOPERATIVE TARGET CAPTURE BASED ON MULTI-SOURCE VISUAL INFORMATION FUSION ALGORITHM

Abstract

With the expansion of human's space resources exploitation and space applications, the number of space debris is also increasing. Space debris poses a great threat to human space activities, and how to control the number of space debris has always been a hot pot in aerospace field. For the expired spacecraft or post-mission rocket upper stage on orbit, these large-scale space debris are usually non-cooperative, which can not provide effective cooperative information. That is, non-communicative in communicated, and non-cooperative in body behavior, etc.. And their movement are more complicated, usually accompanied by relative attitude rotation or even rolling. Space non-cooperative targets capture is an extremely cutting-edge and challenging topic in the space field at present. The capture ways of large-scale debris are usually divided into rigid capture and flexible capture. There is a problem of high difficulties in accuracy control by flexible ways such as net capture. Thus it is a near-term feasible method to use the robotic arm to capture and drag the large-scale debris out of its original orbit based on visual guidance information. However, the traditional monocular or binocular visual is easy to be blocked while robotic arms are moving and a risk of failure is existed. This paper introduces a novel method of capturing space non-cooperative targets based on multi-source visual information fusion algorithm. For large-scale non-cooperative targets such as the expired spacecraft or post-mission rocket upper stage, firstly the shape, position and attitude of the whole target and the graspable parts are measured by binocular vision through recognition, matching and three-dimensional reconstruction method. Then a multi-source information fusion of the position and attitude information of the target's graspable part is realized through "fixed position binocular vision+moving position monocular vision"., which improves the accuracy and reliability of information, and the obtained visual information provides inputs for the autonomous motion planning of robotic arm. Finally, through a multi-constraints optimization search algorithm and online autonomous motion planning, a real-time, optimized and updated design of the capture path within the reach of robotic arm can be realized, which provides inputs for the implementation of non-cooperative target capture. Visiual field constraints, joint constraints, interference constraints and other factors are comprehensively considered in this paper.The feasibility of this method is verified by

numerical simulations and non-cooperative target capture ground tests. And the validity and real-time performance of this method are verified by a flight demonstration test.