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# A NOVEL ADAPTIVE CAPTURE DEVICE AND CONTROL METHOD FOR SPACE DEBRIS

**Abstract**

At present, typical contact Active Debris Removal (ADR) methods for space debris focus on the capture of specific structures, piercing into debris or the overall envelope, with certain stability and flexibility. However, these methods only would be valid for specific structures and debris with required shapes and sizes , or cannot achieve repeatable capture. In this paper, an adaptive capture device and the control method is proposed to full fill the ability to repeat capture the common structures such as the edges, point edges or surface of space debris with different shapes and sizes.

Firstly, the key idea of the device is to construct a adaptive capture volume by elastic claw. The claw has several elastic fingers which could change the pointing direction and is folded with thin film. The claw can unfold the film to form a net and fold the film when necessary. With the cooperation between fingers and film, the claw will be able to adapt the shape of the captured points or areas, and the capture difficulty and precision will be decreased. The elastic fingers will absorb the impact energy during contact process decrease the damage of the targets. Three capture strategies for targets with different size are proposed based on the device.

Secondly, for the process of boundary capture of points/edges, we use Hertz contact theory for dynamic modeling, and considering the friction in the contact process, we introduce the Lugre model to correct it. It provides dynamic constraints for the selection of the optimal capture point later.

Thirdly, the method to determine the optimal capture point/area are proposed. Different contact points have different effects on attitude stability during the capture and the consumption of detumbling control after capture, using the analysis of the boundary contact area, a method combining Particle Swarm Optimization (PSO), and PD control is proposed to determine the optimal capture point/area.

Finally, the simulation is finished. The results show that the capture device can realize the repeated capture of debris with different size (0cm to 250cm) and different shapes, which reducing the capture accuracy requirements to ten centimeters. Further ground tests are wished to show that the proposed adaptive capture device and manipulator method are technically feasible and have great potential for future space debris ADR.