Paper ID: 25025
oral
student

SPACE DEBRIS SYMPOSIUM (A6)
Poster Session (P)

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MOTION AND CONTROL OF DEBRIS CAPTURE WITH SUPER MULTI-LINK SPACE MANIPULATOR

Abstract

This paper is on control method of the new concept debris capture system using the smart material actuator. The smart material actuator is a capsule type actuator with a band of hydrogen storage alloy pasted in the inner wall. The deformation of the alloy by the discharge of the hydrogen inside the capsule will change the shape of the capsule which will be used as the actuator. The displacement of the actuator is very small, but the weight of each actuator is less than 10 grams which leads to the concept of new debris capture with super multi-linked manipulator.

The inspiration from natural environment is the capturing structure of the octopus. They have unique flexible arm that surrounds the target inside their arms. The super multi-link manipulator is designed to realize these flexible arms. This paper is on the motion simulation and control method of super multi-link manipulator to capture debris using the capsule type actuators with hydrogen storage alloy.

Two-dimensional simulator has been developed in order to simulate the motion of the debris capture and the incoming debris. The simulator has enabled the simulation of super multi-link manipulator with lateral motion,

rotational motion, oblique collision and multiple collisions. The simulator has shown complex motion of the manipulator and debris interacting with each other as the collision takes place inside the manipulator. The motion differs by the parameters of closing manipulator, conditions of incoming debris, and the condition of the impact location.

Furthermore, the tether and thrusters has been applied on the debris capture in order to synchronize the motion of the manipulator with incoming debris. Simulation of the tether and thrusters revealed the tendency of the motion for each of the vertical and horizontal directions and the direction of rotation. Using the tendency of the gains together with the impact reaction obtained from the simulations have led to the appropriate control of relative motion with debris in various directions and led to successful capturing of the debris. By applying the tethers and thrusters, the robustness of debris capture has increased largely. The know-hows obtained from this study will help to clarify the complex motion of debris capture and to develop the practical debris capture in the near future.