20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 20th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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ADAPTIVE DETUMBLING AND INTERNAL FORCE CONTROL OF A NON-COOPERATIVE TARGET OPERATED BY DUAL-ARM SPACE ROBOT

Abstract

Space robots will be one of the most challenging and promising astronautical technologies and will play an important role in the field of on-orbit servicing, especially when performing operations of dealing with space debris. Applications of the multi-arm space robot will be more effective and flexible than single arm when the target is tumbling. Once the end-effectors of the space robot contact with the target, it is required to detumble the target's motion as soon as possible and stabilize the base synchronously in the post-capture phase. However, it is not impossible to know the knowledge of the target inertia in advance. Additionally, internal force control can maintain the target undamaged and ensure the safety of the manipulation mission after capturing. Accordingly, particular detumbling and internal force control techniques have to be developed to cope with the challenging post-capture issue.

This paper presents an integrated control scheme for target detumbling and internal force control by using dual-arm space robot. Firstly, the problem of the target tracking a detumbling trajectory is defined and addressed using adaptive feedback control, which does not require knowledge of the target inertia. A Lyapunov argument is employed to show that detumbling is achieved globally. Next, a coordinated control algorithm is proposed for multi-arm space robot, while two control objectives internal force control and load distribution can be accomplished concurrently. The internal force control mechanism ensures the internal forces on the target keeping at a desired level. The load distribution mechanism distributes control effort to each manipulator according to a weighting factor. On this basis, multi-arm space robot can realize the objectives of target adaptive detumbling and safe manipulation. Simulation results are presented for the designed adaptive detumbling and internal force control scheme for dual-arm robot mounted on a spacecraft and demonstrate the effectiveness of the proposed method.