Design of Robust and Intelligent Controller for Active Removal of Space Debris

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Abstract : With huge kinetic energy, space debris poses a major threat to astronauts' space activities and spacecraft in orbit if a collision happens. The active removal of space debris is required in order to avoid frequent collisions that would occur. In addition, the amount of space debris will increase uncontrollably, posing a threat to the safety of the entire space system. But the safe and reliable removal of large-scale space debris has been a huge challenge to date. While capturing and deorbiting space debris, the space manipulator has to achieve high control precision. However, due to uncertainties and unknown disturbances, there is difficulty in coordinating the control of the space manipulator. To address this challenge, this paper focuses on developing a robust and intelligent control algorithm that controls joint movement and restricts it on the sliding manifold by reducing uncertainties. A neural network adaptive sliding mode controller (NNASMC) is applied with the objective of finding the control law such that the joint motions of the space manipulator follow the given trajectory. A computed torque control (CTC) is an effective motion control strategy that is used in this paper for computing space manipulator arm torque to generate the required motion. Based on the Lyapunov stability theorem, the proposed intelligent controller NNASMC and CTC guarantees the robustness and global asymptotic stability of the closed-loop control system. Finally, the controllers used in the paper are modeled and simulated using MATLAB Simulink. The results are presented to prove the effectiveness of the proposed controller approach.
Keywords : GNC, active removal of space debris, AI controllers, MatLabSimulink

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