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SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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DYNAMIC AND CONTROL BASED ON SINGULAR PERTURBATION THEORY OF FREE FLOATING FLEXIBLE SPACE MANIPULATOR DURING CAPTURE UNCERTAIN DEBRIS

Abstract

The main issue of this paper is about the free floating space manipulator capture uncertain debris operation. The stabilization control and vibration suppression control of the flexible space manipulator during capture uncertain debris is presented in this paper. Firstly, the dynamical model of the free floating space manipulator system is derived with Lagrange formula; the last link of the manipulator is considered as a flexible link, one end of this link is under the constraint of a rotating hinge which connected with the previous rigid link, the other end of this link is the capture hand, this hand will combine with the debris after capture operation, base on the above constraint, the flexible link is looked as a simply supported beam, and the model of flexible link is derived with Euler Bernoulli beam theory; The debris is considered as a rigid body, the dynamic model of the debris is derived with the Newton Euler method. Secondly, base on the dynamic models of the space manipulator and debris, the impact effect is calculated from the momentum principle during the capture operation, after the successfully capture, the initial momentum of the debris has a new distribution in the space manipulator and debris combined system, this will cause the motion state of the space manipulator and debris combined system change without active control: the attitude of the space manipulator base and the joint angle will change, the components of the combined system will interfere and the flexible link will vibrate; all these will cause great harm for the space manipulator and uncertain debris combined system after the capture operation. Thirdly, the combine dynamic model of the space manipulator and debris is derived, and then the new combine dynamic model is decompounded into two subsystems base on the singular perturbation theory: the fast subsystem represent the flexible vibration, the slow subsystem represent the rigid motion of the new combine system after capture; a LQR(linear quadrics regulator) optimal controller is designed base on the fast subsystem to suppress the vibration, a RBF(radial basis function) NN(neural network) compensate controller is designed base on the slow subsystem to calm down the rigid motion and overcome the uncertain influence. Finally, the computer simulations are carried out and the result verify the feasibility of the above designed controllers.