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IMPACT DYNAMIC ANALYSIS, VIBRATION CONTROL AND ELM ADAPTIVE CONTROL OF FLEXIBLE SPACE MANIPULATOR CAPTURING A SATELLITE

Abstract

Space manipulator is an important tool in the process of space exploration, it takes many missions in micro-gravity condition in outer space, such as reception of support module, daily maintenance of space equipment, removal of failure orbit satellite. The space robot manipulator is usually made of light long links based on the consideration of launch costs and spaces applications. Hence, the flexibility of manipulator should not be neglected. The dynamic evolution for space manipulator with flexible links impacted by a satellite is analyzed; the calm control and vibration control problems for composite system after the capturing operation are studied. With the law of conservation of momentum and the transferring law of force, the motion states of the composite system after capture are solved by the integral and simplified process and the dynamic equations of composite system are obtained. Then, based on the singular perturbation theory, the dynamic equations of composite system are decomposed into fast subsystem and slow subsystem which represent the flexible vibration and rigid movement respectively. The adaptive control method based on Extreme Learning Machine (ELM) is designed for slow subsystem—the base attitude and joint motion system of space manipulator. The ELM has advantages of faster learning rate and only need to adjust the output weights value of network which is used to approximate uncertain part of system. The linear quadratic optimal control is applied for fast subsystem to suppress the flexible vibration. The changes of motion states of composite system after capturing operation are simulated by numerical simulation. The simulation results show that the proposed composite scheme is effective for motion control and vibration control.