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AN ONLINE ONE-STEP MOMENTUM-BASED INERTIAL PARAMETER IDENTIFICATION TECHNIQUE FOR SPACE ROBOT WITH UNKNOWN LINEAR AND ANGULAR MOMENTUM

Abstract

Since the launch of Sputnik I, space activities have created an orbital debris environment that poses increasing impact risks to existing space systems, including human space flight and robotic missions. Space robotics is considered as one of the most promising approaches for orbital debris removal missions. However, for space robot, motion of base and arm are strongly coupled because of the floating base. The inertial parameters of the whole robot should be obtained well for system control especially attitude control, but they may vary after launch due to fuel consumption hardware reconfiguration, target capturing, and so on.

This paper presents a momentum-based online one-step identification technique for obtaining all the inertial parameters of the whole space robot with initial linear and angular momentum. The equation of linear and angular momentum of the whole system is utilized to obtain the identification equation. Measurements include displacement and velocity of base and joints as well as control force and torque from the base. For obtaining the mass and mass center of all the bodies, the equation of linear momentum is used, and the identification equation can be solved by recursive least square (RLS) method after linearization. However, for identifying inertia tensor, the second-order term $m_i\mathbf{r}_i \times \mathbf{v}_i$ should be written as the product of function of time as well as mass and mass center of all the bodies, and a modified RLS method is utilized here which can obtain the inertia tensor when the mass and mass center are estimated. Thus for identification, in each iteration, mass and mass center of all the bodies are obtained at first then the corresponding inertia tensor of all the bodies can be estimated without iteration from the beginning once again.

To verify the identification technique, 2D and 3D models are both simulated and analyzed. In simulation, all the estimated values converge to their real values. Compared with the previous multi-step method, the method here can be achieved via only one-step which costs less time or space for data storage.