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MULTIDUAL QUATERNIONS BASED DYNAMICS MODELING FOR A RIGID-FLEXIBLE COUPLING SPACECRAFT AND APPLICATION

Abstract

Recently, on-orbit service, formation flight, rendezvous and docking, fuel filling, and other close-distance operations have attracted increasing attention from researchers. Traditional control methods assume that the translation and rotation of spacecraft are decoupled, and spacecraft control adopts the serial control mode of alternate attitude and orbit control. As early as the 1960s, the position and attitude coupling characteristics of dual quaternions were applied in space robotics and astrodynamics. As a result, the kinematics theory of dual and multidual quaternions has become increasingly complete. In computer vision, kinematics theory based on dual and multidual algebras has the advantages of low memory occupation, singularity-free, accurate interpolation, and has been widely used in animation production. In the field of dynamics and control, recent papers analyzed the characteristics of the dual and multidual quaternion kinematics model. They gave the corresponding generalized control from the viewpoint of Lie groups and Lie algebras. In actual space missions, solar panels and flexible antennas must often perform sun-pointing or earth-pointing guidance. According to mission requirements, the configuration of flexible attachments often needs to be symmetrical. This requires the establishment of system dynamics equations under any configuration of flexible attachments. As early as the 1960s, the position and attitude coupling characteristics of dual quaternions were applied in space robotics and astrodynamics analysis. As a result, the kinematics theory of dual and multidual quaternions has become increasingly complete. In the field of dynamics and control, recent papers analyzed the characteristics of the dual and multidual quaternion kinematics model. They gave the corresponding generalized control from the viewpoint of Lie groups and Lie algebras. In actual space missions, solar panels and flexible antennas must often perform sun-pointing or earth-pointing guidance. According to mission requirements, the configuration of flexible attachments often needs to be symmetrical. This requires the establishment of system dynamics equations under any configuration of flexible attachments.To improve the current dual quaternion dynamic modeling theory, we propose a multidual rigid body dynamic equation suitable for general form by introducing a new multidual derivative concept. Based on the same modelling framework, we deduce and establish a complete system dynamics model with translation-rotation vibration coupled by integrating the vibration of the flexible appendages into the modelling system. The model is suitable for flexible appendages with any configuration. The correctness of the theory is verified by numerical simulation