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HIGHER-ORDER CAYLEY TRANSFORM FOR RELATIVE POSE PARAMETERIZATION OF SPACECRAFT

Abstract

Spacecraft formation flying, rendezvous operations or distributed spacecraft missions are applications that use the solutions for the classical relative orbital motion problem. The relative motion between a leader and a deputy is a six-degrees-of-freedom (6-DOF) motion that represents the coupling of the relative translational motion with the rotational one. Recently, solutions that involve using a nonlinear adaptive position and attitude-tracking controller for a rigid body that requires no information about the mass and inertia matrix of the body were proposed. This solutions use unit dual quaternions to represent the position and attitude of the rigid body. Our previous investigations showed that any rigid body motion can be globally parameterized using a curve from the Lie group of the orthogonal dual tensors. This result is very important and can be used to improve research in multiple connected areas. Cayley maps are a useful tool when a group needs to be linearized near its identity. This is also true of the exponential map, but the Cayley maps are rational which doesn't involve transcendental functions. This is useful in numerical applications since evaluating transcendental functions can be time-consuming. In this paper we introduce a new approach for pose parameterization by using higher-order Cayley transforms for Lie algebra of orthogonal dual tensor Lie group. This approach completely embeds multiple of the reported attitude parameterization Cayley maps and extends them towards pose parameterization of spacecraft. Using the higher-order Cayley transforms we can recover both the principal parameterization and their shadows, which allow the avoidance of any singularity.The obtained results interest the domains of the spacecraft formation flying, rendezvous operation, autonomous mission and control theory.