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MOTOR ALGEBRA BASED SMALL SATELLITES FORMATION NAVIGATION

Abstract

In this paper we developed a new method to describe satellite's spatial parameters 'Motor'. Motor algebra is a 4D degenerate geometric algebra, with a simple and uniform format to represent 3D parameters; motion of points, lines and planes can be advantageously represented using the algebra of motors. In this paper we focus on the need for small satellite formation flying representation, especially relative motion, and we show that this approach is extremely useful for solving problems in relative dynamics and kinematics calculation. The Motor algebra was firstly taken out by Clifford in 1980s, who utilized it to represent the relative position of two skew lines in space, but he died before he could show us its embedding in the special Clifford algebra. For decades the Motor algebra was not improved, less literatures showed is value in robotic vision and mechanical field, however, dual quaternion, as a subclasses of Motor was used widely. Other than dual quaternion, Motor is much broader and unified; it can represent force and moment, velocity and angular velocity, position and attitude in a strict and uniform format. In our research we developed new equations of dynamics and kinematics for satellite relative motion using Motor algebra, it obviously reduced computational complexity with enhance efficiency; a Motor extended Kalman filter was developed to suit the framework. The real experiments show that the Motor algebra gives more accurate results in the dynamic motion estimation problem.