Paper ID: 37256
student

Poster Session (P)
Poster Lunch (1)

Author: Mr. Xianghao Hou
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,NPU, China

Prof. Yuan Jianping
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China

DUAL VECTOR QUATERNIONS BASED FAULT TOLERANT POSE AND INERTIAL PARAMETERS ESTIMATION OF AN UNCOOPERATIVE SPACE TARGET USING TWO FORMATION FLYING SMALL SATELLITES

Abstract

Estimating the parameters of an unknown free-floating tumbling space target is an essential task for the on-orbit servicing (OOS) and autonomous rendezvous docking (AR&D) missions. Also, the small satellites play vital role in the space exploration and the OOS missions for their lower cost and much faster development cycle compared with the traditional satellites, especially when the missions are simple, the small satellites can only have specific functions to have them accomplished. This paper proposes a dual vector quaternions based fault tolerant pose and inertial parameters estimation algorithm of an uncooperative space target using two formation flying small satellites.

Firstly, by utilizing the dual vector quaternions (DVQ) to model the kinematics and dynamics of the system, not only the representation of the model is concise and compacted, but also the translational and rotational coupled effects are considered. By using this modeling technique along with the measurements from the on-board vision-based sensors, an DVQ based Extended Kalman Filter (EKF) for each of the two small satellites is designed, and each satellite can have its own pose and inertial parameters estimation of the unknown space target by the designed DVQ-EKF.

Secondly, both of the estimations from each small satellites will be used as inputs of the fault tolerant algorithm which run in the on-board computer (OBC) of both of the two small satellites. This algorithm is based on the fault tolerant Federal Extended Kalman Filter (FEKF) strategy to overcome the estimation errors caused by the faulty measurements, the unknown space environment and the computing errors by setting the appropriate ratios of the two estimations from the first step DVQ-EKF. Together with the first and second steps, a novel fault tolerant DVQ-FEKF using two formation flying small satellites is proposed by this paper to estimate the pose and inertial parameters of an free-floating tumbling space target.

As far as the author knows, the designed DVQ-FEKF is the first dual vector quaternions based fault tolerant pose and inertial parameters estimation algorithm of an uncooperative space target using two formation flying small satellites. By utilizing the estimation algorithm, a good prior knowledge of the unknown space target can be achieved. Finally, the proposed DVQ-FEKF is validated by mathematical simulations to show its robust performances.