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A MONOCULAR-BASED RELATIVE POSITION AND ATTITUDE FILTERING FOR UNKNOWN TARGETS

Abstract

An EKF-based filtering is developed for the relative position and attitude estimation of unknown targets with respect to an active spacecraft in a fly-around or an approaching/docking mission. A monocular camera fixed on the active spacecraft is used as the unique relative measurement sensor for obtaining the input information of the filtering. The line of sight (LOS) of the features on the target obtained by the monocular camera is used as the measurement of the filtering. The proposed filtering can be used for the relative position and attitude estimation of any target with unknown geometry and mass property parameters, such as the shape, size, inertia moment, and the centroid of the target. The states of the filtering include the relative attitude quaternion, angular velocity, the inertia ratios of the target, relative position and translational velocity of the target with respect to the active spacecraft, and the position of the target's features with respect to the centroid of the target. The major innovation of this work lies in that, the authors present a new algorithm for solving the relative position and attitude of a totally unknown target using only the LOS information obtained by a monocular camera, as a contrary in the existing research, using which we can only obtain the relative position and attitude of a cooperative target or a target with a prior knowledge. The observability of the proposed filtering is similar to that of the range-observability problem, but more complex, based on the knowledge of which an observability analysis is given. From the analysis, the key factors that enable the proposed filtering are found, which are the offset of the camera to the centroid of the active spacecraft and the maneuvering conducted by the active spacecraft, respectively. At last, a numerical simulation is given, by the results of which the proposed filtering is verified.