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TRACKING OF UNCOOPERATIVE MANEUVERING SPACE TARGETS USING SPACE-BASED ANGLE-ONLY MEASUREMENTS

Abstract

The issue of uncooperative space target tracking has along been the focus of target motion analysis. The interacting multiple model (IMM) and its extended methods are popular to be used in the issue in lots of literature. However, unlike the aircrafts and the ground vehicles, the motion of space targets cannot be simply modeled to be a straight or turn motion with a constant velocity or a constant acceleration. The motion of the space targets involves complicated dynamics. Furthermore, the space-based angle-only measurement does not get the distance and velocity information of the space targets. Therefore, the precise tracking of a maneuvering space target using only the space-based angle measurements is indeed a issue and is not fully resolved, especially for the uncooperative space target, which is further addressed in this paper. To solve the influence of maneuver on the motion state estimation, two strategies for the precise motion state estimation are brought forward, i.e., the Q-matrix improvement strategy and the filter restart strategy. A tracking filter with a single state model using one of the two strategies can achieve a tracking capability as perfect as an IMM method. Finally, the tracking capability of the two strategies on the space targets with different maneuvers is numerically simulated and compared with that of the normal extended Kalman filter. The research and the simulations show that the Q-matrix improvement strategy can achieve a success ratio of precise tracking of 100 percent for space targets with a small maneuver and larger than 90 percent for targets with a big maneuver. The weakness of the Q-matrix improvement strategy is that the determination of its parameter requires some experience or technique. Comparatively, the filter restart strategy can achieve a success ration of precise tracking of 100 percent for space targets with any maneuver. The research is beneficial to the space target motion analysis and the issue of space situation awareness.