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INTELLIGENT INTEGRATED NAVIGATION OF SOLAR SYSTEM BOUNDARY EXPLORATION CRUISE PHASE BASED ON Q-LEARNING EXTENDED KALMAN FILTER

Abstract

With the continuous advancement of deep space exploration missions, the mission of solar system boundary exploration is established as one of the most important deep space scientific exploration missions in China. The mission of the solar system boundary exploration has many challenges such as ultra-remote detection distance, ultra-long operation time and ultra-long communication delay. Therefore, the problem of high-precision autonomous navigation needs to be solved urgently. This paper designs an intelligent integrated navigation method based on X-ray pulsars and solar/planetary observation information in the cruise phase, which can estimate the motion state of the probe in real-time. The proposed navigation method employs the Q-learning extended Kalman filter (QL-EKF) to improve the navigation accuracy during long periods of self-determining running. The QL-EKF can select automatically the error covariance matrix parameter of the process noise and the measurement noise by the reward mechanism of reinforcement learning. Compared to the traditional EKF and UKF, the QL-EKF can improve the estimation accuracy of position and speed. Finally, the simulation result demonstrates the effectiveness and the superiority of the intelligent integrated navigation algorithm based on QL-EKF, which can satisfy the high precision navigation requirements in the cruise phase of the solar system boundary exploration.