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IMPROVING THE ORBIT DETERMINATION AND PREDICTION ACCURACY USING GAUSSIAN PROCESS REGRESSION

Abstract

When a space object is first detected, only a few observations are available. In this situation, the orbit determination accuracy is limited, which affects the orbit prediction accuracy significantly. This paper models the orbit determination error through the machine learning approach and rebuilds the orbit prediction error. A 3.5-year orbit for a space object was simulated using the high-fidelity orbit propagator, and the corresponding observations were generated by five optical sensors. Firstly, the orbit determination errors were modeled with the Gaussian Process Regression algorithm. Nineteen parameters that affect the orbit determination accuracy are used as the learning parameters. After the compensation of the machine learning model, the remaining semi-major axis determination errors were less than 0.1 km, while the original errors reached dozens of kilometers. Then the orbit prediction errors were rebuilt by the estimated orbit determination error and the dynamic model. For the 7-day orbit prediction, the remaining radial and transverse errors were reduced from thousands of kilometers to less than 200 km, and the remaining normal errors were less than 10 km. In the test set, more than 90% of the accumulated prediction error was eliminated.