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ORBIT PREDICTION PRECISION IMPROVEMENT OF LEO SPACE OBJECTS AND ITS APPLICATION IN COLLISION RISK ESTIMATES

Abstract

Accurate orbit prediction plays an important role in collision risk estimates. Since LEO (Low-Earth-Orbit) space objects orbit in the area where atmospheric density is greater, atmospheric drag is the biggest disturbing force to them, and changes of space environment could affect their orbit prediction precision. A new method to improve the orbit prediction precision is proposed in this paper, and its application in collision risk estimates is also discussed. Based on SGP4 (simplified general perturbations-4) model, the optimal values of drag coefficient for short-term orbit prediction (Best-Bstar) are selected by simulating and comparing the prediction results to real-time TLE (two line elements) values. The relations among the optimal drag coefficient, the drag coefficient in TLE, solar index and geomagnetic index are studied. Subsequently, neural network model is built to forecast the optimal values which are suitable to short-term orbit prediction. It can be found that the optimal values are one or two days ahead the values in TLE, and they are all corresponded with F10.7 and Ap indices, and neural network model could timely response to space environment disturbance. This method is applied in Tiangong-1 and International Space Station orbit prediction to verify its validity and universality. Results show that the comparatively large errors in downrange direction decrease markedly, especially during geomagnetic disturbance period. Generally, this method could improve the orbit prediction precision by 30 percent, and success rate of improvement is about 80 percent. In addition, according to random point simulation, a method to calculate the collision probability is proposed. Application of prediction precision improvement in collision risk estimates is also discussed.