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A STUDY ON THREE ARTIFICIAL NEURAL NETWORKS IN GRAVITATIONAL MODEL OF SMALL SOLAR SYSTEM BODIES

Abstract

Nowadays, small solar system bodies such as asteroids and comets have advocated the core attention of space agencies and communities as there are some renowned missions to these bodies. Irregular shapes and weak gravitational fields of asteroids make such mission design extremely challenging. Considering the effects of these factors, gravitational modeling with high accuracy and reliability should be investigated. The polyhedral model is known as the most suitable model to describe the gravitational field of asteroids and comets. Due to the high computational burden of the polyhedral model, learning network utilization can be applied as considerably applicable in time decreasing. In this paper, we investigate the accuracy of three intelligent gravitational models of irregular asteroids considering 433 Eros asteroid as a case. First, the polyhedron model of the target is derived using accurate real data gathered by the Database of Asteroid Models from Inversion Techniques (DAMIT). Then, the learning methods using multilayer perceptron (MLP), rough neural networks, and radial basis function (RBF) network are derived to estimate the onboard gravity accelerations of the asteroid. In this regard, we attempted to predict the gravitational field gradient with a large dataset which considered randomly in a spherical shell around the target asteroid as a region for sample data generation. The gravitational accelerations are validated through comparison with the counterpart values obtained by polyhedron model. This research aims to propose the most accurate and rapid model which improves the autonomy and intelligence of asteroid missions. Performance evaluation is compared using two verification statistic metrics (MSE and RMSE) between the experimental data and predicted values. Finally, simulation results of estimating the gravitational acceleration of the 433 Eros are given to substantiate the effectiveness of these techniques to reduce computational burden and illustrate the real-time performance, and accuracy of the developed learning-based gravity models.