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A GNSS RECEIVER FAULT DIAGNOSIS METHOD BASED ON FEATURE RECONSTRUCTION AND DEEP FOREST MODEL

Abstract

Global navigation satellite system (GNSS) receivers shall have the ability of fault detection, isolation, and fault handling since they may suffer from performance degradation or even function loss of navigation, positioning, and timing due to severe space environments. Due to the limit of experts' cognitive ability, deep learning models with strong feature learning ability and end-to-end diagnosis characteristics have been applied to recognize unknown faults or coupling faults outside of the fault rules. However, high computing and time cost is a main challenge for space applications. In this paper, we present a non-neural network deep forest framework for GNSS receiver fault diagnosis based on feature reconstruction to meet the requirements of model simplicity. Maximum pooling and t-distributed stochastic neighbor embedding techniques are applied for feature reconstruction in the multi-grained scanning and cascade forest structures of the deep forest models to eliminate redundancy information and optimize model features. Fault injection tests on GNSS receivers are conducted to obtain reception signal quality-related telemetry data. Then experiments on GNSS receiver fault diagnosis are carried out and results show the average diagnostic accuracy of the proposed method can reach 0.9807 and outperforms existing random forests, LightGBM, XGBoost, LSTM, and CNN-based fault diagnosis methods.