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GPS CARRIER-TO-NOISE DENSITY PREDICTION USING REGRESSION TREES

Abstract

The carrier-to-noise density (CND) measured by global positioning system (GPS) receivers can be used as an indicator of signal quality and to predict the receiver's performance. It is the ratio of the carrier power to the noise power per unit bandwidth, expressed in decibel-Hertz (dB-Hz). The traditional method of estimating the CND involves computing the narrow-band wide-band power ratio of the received GPS signal in real-time. In this work, we propose using regression trees to predict the carrier-to-noise density of GPS signals based on commonly available spatial and temporal parameters, such as time of day, observed GPS satellite pseudorandom noise (PRN) code, azimuth, and elevation of the observed GPS satellites. To this end, observations for a period of two years from a GPS receiver at Sharjah (25.3N,55.5E) have been used in the training and validation of the evaluated regression tree models. Four different models were tested: linear regression (LR), regression tree (RT), boosted, and bagged RT. These four models were trained then evaluated. The bagged RT model performed best in terms of root mean squared error (RMSE) and R-squared. The Bayesian optimization was used to optimize the bagged RT model by searching for the optimal hyperparameters that minimize the mean squared error of the prediction. The optimal bagged RT produced an estimation model with a mean absolute error of around 1% of the mean CND, with an R-squared value of 0.99, and a prediction speed of 380k observations per second. The proposed CND prediction method should allow the user to predict the CND for different GPS

satellites beforehand, enabling the user to prioritize data processing from the satellites with the highest CND values, thus improving the positioning accuracy of GPS receivers. Additionally, this prediction will provide a baseline for the user to compare real-time observations in order to detect unexpected anomalies that deviate from the predicted value.