IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Space Communications and Navigation Global Technical Session (8-GTS.3)

Author: Mr. Muhammad Muneeb Shaikh
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan

PERFORMANCE EVALUATION OF CEEMDAN-LSTM MODEL FOR TEC FORECASTING OVER LOW LATITUDE GNSS STATIONS

Abstract

Ionosphere is one of the main sources of error on Global Navigation System (GNSS) as it affects the propagation of GNSS signals and can lead to errors in position measurement. Ionosphere is influenced by temporarily & spatially varying attributes which makes the ionospheric Total Electron Content (TEC) signals as nonlinear and non-stationary. The behavior of ionosphere gets further non-deterministic and unpredictable in the low latitude regions due to the complex electrodynamics which in turn further limits the performance of GNSS systems in modern technological infrastructures and applications. Therefore, forecasting of ionospheric TEC is necessary to undertakes measures to improve the performance of GNSS systems. In our study we have utilized unique combination of signal processing (Complete Ensemble Empirical Mode Decomposition with Adaptive Noise - CEEMDAN) and deep learning (Long Short Term Memory - LSTM) techniques to drive the CEEMDAN-LSTM model for predicting the ionospheric TEC signals. In the proposed CEEMDAN-LSTM model, CEEMDAN technique reduces the non-linearity of the TEC signals by decomposing it into several intrinsic mode functions (IMFs) which are then predicted by the LSTM network with better accuracy. This study evaluates the performance of proposed CEEMDAN-LSTM model with the Neural Network, LSTM, and the International Reference Ionosphere (IRI) models on the low latitude GNSS station in Pakistan & surrounding during the geomagnetic disturbed and quiet days. The Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) of the predictions from the proposed model were observed to be 50% and 70% better compared to other deep learning and empirical models