

Performance evaluation of artificial neural network and hybrid artificial neural network based genetic algorithm models for global horizontal irradiance forecasting

Wahidna, A., Sookia, N., Ramgolam, Y.K.

Abstract

The output of photovoltaic (PV) systems is highly dependent on Global Horizontal Irradiance (GHI). Thus, accurate prediction of GHI is essential to meet increasing energy demands, stabilise the electric grid system and mitigate climate change. The main objective of this study is to accurately model and forecast GHI at Albion, Mauritius for a time step of every 15 min using the Artificial Neural Network (ANN) and hybrid Artificial Neural Network based Genetic Algorithm (ANN-GA) techniques. Ground-based measurement (GBM) data, collected every 15 min for a winter month was checked for stationarity and normalised to enhance its quality. Only strongly correlated input variables were selected to minimise uncertainties in forecasts. Special emphasis is given to short-term forecasting with a relatively small dataset size. This work is repeated for 30 min and 1 h time scales. The study is further validated using satellite data for a different location (Curepipe) in Mauritius. The performance evaluation over different statistical metrics indicated that the ANN model has the best capabilities for GHI forecasting, regardless of the location. The highest quality forecasts from the ANN technique resulted in values of 0.9999 for correlation coefficient (r), 0.9999 for coefficient of determination (R^2), 0.1537 W/m² for Mean Absolute Error (MAE), 0.0641 W/m² for Mean Square Error (MSE) and 0.2532 W/m² for Root Mean Square Error (RMSE). The best ANN technique outperformed the strongest hybrid ANN-GA technique for every measured performance indicator.

Keywords: Solar energy, Global horizontal irradiance, Forecas, Artificial neural network, Genetic algorithm

The paper was published in Solar Energy Advances as part of the SWC2023 select papers.

10.1016/j.seja.2024.100054