Probabilistic Wind Power Forecasting with Hybrid Artificial Neural Networks

The uncertainty of wind power generation imposes significant challenges to optimal operation and control of electricity networks with increasing wind power penetration. To effectively address the uncertainties in wind power forecasts, probabilistic forecasts that can quantify the associated probabilities of prediction errors provide an alternative yet effective solution. This article proposes a hybrid artificial neural network approach to generate prediction intervals of wind power. An extreme learning machine is applied to conduct point prediction of wind power and estimate model uncertainties via a bootstrap technique. Subsequently, the maximum likelihood estimation method is employed to construct a distinct neural network to estimate the noise variance of forecasting results. The proposed approach has been tested on multi-step forecasting of high-resolution (10-min) wind power using actual wind power data from Denmark. The numerical results demonstrate that the proposed hybrid artificial neural network approach is effective and efficient for probabilistic forecasting of wind power and has high potential in practical applications.