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A weighted hybrid wind turbine power curve modeling approach using spline regression and theoretical power curve

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Empirical wind turbine power curve modeling is often used to improve wind power forecasting. This is mostly due to the fact that theoretical power curves released by manufacturing companies are based on ideal meteorological and topographical conditions for wind turbines. However, wind turbines are never used under ideal conditions, and the empirical power curves could be substantially different from the theoretical ones. On the other hand, empirical power curves could be very far from the theoretical ones for several reasons including the sensitivity of the model fitting approach to the outliers and variability of observed data points, etc. Different techniques of wind turbine power curve modeling have been proposed which can be classified into parametric techniques and non-parametric techniques. In this paper, we propose a new hybrid method for predicting the values of generated wind power using wind speed data by combining both theoretical and empirical power curve models, using a weighting scheme that leads to improvement of fitted model accuracy and considers the heterogeneity of wind speed-power data. As historical data is not homogeneous in all range of wind speed and often the variance of wind power increases as wind speed increases, the proposed approach provides an efficient way to incorporate this heterogeneity in the wind turbine power curve fitting process. To this end, we use natural spline methods to obtain empirical power curves and combine them with theoretical power curves using a local weighting scheme that is based on the speed value and the corresponding variance of generated power values at that speed value. We show that our proposed method outperforms other benchmark fitting methods by comparing root mean squared error and mean absolute error as accuracy metrics on a historical data of wind turbine farm in Manitoba, Canada. The outcome of this study can be used in various applications such as turbine performance monitoring and power forecasting.

Biography

Mehrdad Mehrjoo received the B.Sc. degree in Computer Engineering from Shiraz University, Fars, Iran, and the M.Sc. degrees in Computer Engineering from Sharif University of Technology, Tehran, Iran, in 2012 and 2015, respectively. Currently, he is a Ph.D. Candidate under supervision of Dr. Pawlak and Dr. Jafari Jozani in the Department of Electrical and Computer Engineering, University of Manitoba, Winnipeg, MB, Canada. His research interests include Machine Learning Methods for time series as well as parametric and nonparametric inference using regression methods and recently developed interests in the application of modern statistical methods in renewable energy and stochastic modeling of wind turbines power forecasting and performance monitoring.

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