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POWER CURVE MODELLING FOR WIND TURBINES

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The energy crisis is a major problem in the world, and as a solution to the problem, wind energy plays a strategic role. Wind energy-based plants grow expeditiously among the energy plants due to sustainability and emission reduction requirements and cost-effectiveness. The uncertain nature of wind makes considerable challenges to the reliability and stability of wind power plant projects. Therefore, to overcome these challenges, power curve models are designed to predict power output with respect to wind speed. Accurate models of power curves can play an essential role in improving the performance of wind energy-based systems. Modeling methods usually use data from manufacturers' specifications and actual data from wind farms. In this regard, various modeling techniques are available, and in our work, existing polynomial function approximation is adopted. This research paper discusses modelling an effective power curve for wind turbines, which are located in the Puttalam District. The power curves have been developed for actual data using SPSS statistical analytical package and Python programming language for each wind turbine. Then, a quadratic model and a cubic model were developed for each wind turbine. Furthermore, a comparison of developed quadratic and cubic power curve models with respect to actual power output data was performed. The errors were calculated for quadratic and cubic developed models using the root mean square error method, and it indicated 156.70 and 160.18, respectively. Through these comparisons, it was detected that the gradient of both models should increase to minimize the errors of these models. Accordingly, the quadratic and the cubic model were differentiated, and modifications to both models were performed using the trial and error method under several conditions to reduce the root mean square error. This novel heuristic approach resulted in effective models on comparison of the graphs of the modified models with the actual data. Further, the errors were calculated for these modified power curve models with respect to actual power output data and indicated 28.48 and 63.43, respectively, thus depicting an accurate fitting for the actual data.

Keywords: Power curve modeling, Root mean square error, Wind Energy