NEURAL NETWORK MODEL FOR FORECASTING SOLAR ENERGY GENERATION AND ANALYSIS OF POWER OUTPUT CONTROLLING BY ENERGY STORAGE SCHEMES

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Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa
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Declaration

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Prof. R.A Attalage

Abstract

Modeling of power fluctuations in a solar PV power plant using an Artificial Neural Network (ANN) was carried out in the study. The resulting model was used to evaluate the energy storage requirement to control fluctuations of the power output. The ANN was trained to model the output of a 300kW solar PV system installed in Colombo with an average hourly energy output of 90.55kWh and an average daily energy production of 1177 kWh. The ANN model proved to deliver forecasts with significant accuracy and generalizability. Correlation coefficients for training, validation and testing were 0.945 0.948 and 0.939 respectively. Further validation was done using an isolated data set of a time period of a month for which model was able to achieve a correlation coefficient of 0.93. Residual analysis confirmed the error was random and free of autocorrelation. Error terms had a normal distribution with mean 1.09kWh and standard deviation of 20.06kWh. A direct mapping was established between meteorological parameters and power output of a solar PV system, as oppose to estimating solar irradiance. Energy storage requirement was evaluated for two power output control schemes. First scheme specifies a ramp up, ramp down rate, and a continuous power delivery period. By means of an optimizing algorithm the combination of parameters corresponding to the least energy storage requirement was established and the result for energy requirement was approximately 15% of the average daily energy generation of the PV system. Variation of energy storage requirement under different operating conditions was analyzed further. The second output control scheme uses moving average smoothening to control power output. The calculated energy storage requirement for moving average scheme was approximately 8% of the average daily energy generation. The effect of imposing restriction on operating parameters of the schemes were examined in detail.

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