RECURRENT NEURAL NETWORK-BASED MODEL FOR FORECASTING ELECTRICITY DEMAND IN NIGERIA

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ABSTRACT

Electricity is one of the basic infrastructures of the modern world and Nigeria is currently facing a daunting challenge in the provision of adequate electricity required for sustaining and boosting her socio-economic activities. However, available estimates of electrical energy needs of the country are very divergent, often conflicting, and therefore unreliable. Thus, effective planning for electricity generation, transmission and distribution has become difficult and thereby undermining success of reforms towards meeting the nation's energy need. A major constraint is lack of adequate model for predicting energy needs. This constraint is greatly amplified in a deregulated power sector where load demand forecast is required to plan for generation and match demand with supply. The matching helps in maintaining the integrity of the system because electricity can only be produced and consumed in real time on a large scale. Therefore, the focus of this work is on the development of a model for forecasting electricity load demand using recurrent neural network (RNN) techniques. Relevant data on electricity consumption are collected, pre-processed and tested for non-linearity to determine suitability for training. An Artificial cNeural Network (ANN) with feedback, known as Recurrent Neural Network (RNN), is identified as a tool suitable for predicting electricity demand. The RNN architecture deployed is a modular multi-input, single-output model with twelve neurons using sigmoid activation function and Levenberg-Marquardt training algorithm. The model development was implemented using C++ with the initial weights in the range of -1 to +1 and later improved using the Nguyen-Widrow technique in the hidden layer. The proposed network is simulated as a Non- linear Auto Regressive with eXogenous input (NARX) model using the Levenberg-Marquardt algorithm in MATLAB. The results of the MATLAB simulation indicate that the NARX model is adequate. A mathematical model of the RNN was also developed and solved using Mathematica software package. Substitution of empirical data into the mathematical model shows a variance of -0.004% thereby validating the mathematical model and the suitability of the RNN model. The model correctly predicted the total electricity consumption for the years 2001 to 2003 with a variance of 28% (that is, 72% accuracy) thereby verifying the chosen ANN architecture for a reliable forecast in a real life situation. The mean square error of the developed model is 2.21E-03. The model also predicted that the demand for electricity in the year 2015 will be 548737GWhr; 2020 will be 597811GWhr; 2030 will be 711516GWhr and in 2050, demand will rise to 927476GWhr. The study will guide in, and provide input into, national planning and policy formulation on the electrical energy need of the country.