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Title of Ph.D. Thesis: Soft Computing Techniques Based Load Forecasting

ABSTRACT

The reliability of a power system is its capability of fulfilling the consumer's requirement of electricity. However, due to the digital revolution, the power industry has to maintain high reliability as well as the quality of the supply for dedicated applications. Due to technical reasons, the electricity should be produced and consumed simultaneously.

For efficient and successful operation, a proper balance between generation and consumption is required at all operating points of time. However, there is a continuous change in loads even though there is a constant generation over a period. The electric power demand has been rising steeply to cater to the needs of growing all-around developments like; industry, agriculture, transportation, communications, and other associated sectors.

Now the electric energy requirement depends on the day-to-day actions of the users as the appliances have to be set up and on or off with the customer's choice. Hence during the planning and operation of the energy system, demand forecasting becomes an essential factor. As electricity end uses expand, the electric load forecasting becomes more complicated.

The load forecasting problem has been receiving greater attention as being an important tool in power system planning and operation. Over the decade scientists and researchers have developed different methods and prototypes to solve it as a prediction problem. The variability of modelling approaches is due to the type of available data, nature of load forecast, and behavior of impact parameters that contribute to the variability of load. This research work focuses on proposing and implementing the soft computing technique for load forecasting besides the other. The contents of the work carried out in the thesis are summarised in the following paragraph.

The identification of work is carried out in Chapter 1. It includes the Introduction to power system planning, the need for forecasting, its classification, and the factors affecting it. An overview of forecasting principles is also presented. A brief on methods of forecasting is presented, and the theoretical background of soft computing techniques has been given. The concepts of soft computing applied to load forecasting have been summarized. These

techniques can lead to high-quality forecasting helping in decision making. Therefore, integrated techniques which combine the favorable features of different methods are identified. In Chapter 2, the literature review of the work already reported is done. A comprehensive comparative analysis of various existing techniques for load forecasting has been summarized.

An introduction to time series and its application is given in Chapter 3. The incorporation of soft computing techniques with time series to develop fuzzy time series is also described. Following it, different time series methods of forecasting are applied to the real-time data of a substation. The performance is evaluated and compared considering different indices. Moving averages, trend curves, fuzzy time series, as well as hybrid techniques, which combine the special characteristics of artificial neural networks (ANN) with these time series methods, are studied. The inspection of the results achieved shows that ANN-based models outperformed the individual models. An ANN with fuzzy rules with time series was found as the model resulting in the least error.

In Chapter 4, concepts of soft computing applied to load forecasting have been summarized. Among soft computing techniques, ANN and FTS are found most widely used techniques for short-term load forecasting. The Wavelet technique is discussed with its due merits. The FTS, ANN, and an integrated technique consisting of WT and ANN are applied to forecast load using real-time data of a substation. For WT, different levels 1 to 9 of Daubechies db1-db9 wavelets have been applied. The results achieved are compared on different performance indices to identify suitable wavelets. It is observed that Wavelet db3 is the best option for the further load forecasting model. In Chapter 5, WT on real-time data of a substation is used for forecasting. The possible combinations of Fuzzy Time Series, ANN, and Daubechies wavelet db3 are also used for data of the same substation. The wavelet transform is used to decompose the historical load pattern into lower and higher frequency components called approximations and details. These components are forecasted using different techniques like ANN. Finally, inverse wavelet transform is used to reconstruct a forecasted pattern with these forecasted approximations and details. The soft computing techniques, ANN-W, N-FTS-W, and FTS-NN-W, using db3 wavelets had been applied to improve the load forecast models. The developed model FTS-NN-W was found to be the best among these. Finally, work is concluded in the last chapter i.e. Chapter 6. The major conclusion drawn from the work carried out and the scope for the future work is suggested in this chapter.

The data used in this thesis mean hourly load usage in MW, was taken from the Noida based distribution company.