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Load Forecasting using ANN

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Abstract: Accurate load forecasting plays a key role in economical use of energy. Artificial Neural Network (ANN) models have been extensively implemented to produce accurate results for short-term load forecasting with time lead ranging from an hour to a week. In this report daily peak load forecasting has been performed for the part of a town supplied by 2 distribution feeders on weekdays by taking into consideration the historical maximum Power consumption in MWH, Voltage in KV and Current in Amp data. Optimization of the network parameters is performed for both learning rules. Energy demand forecasting is of great importance in the management of power systems. In this report artificial neural network technique (ANN) is used for forecasting the load curve. Algorithms using these techniques have been programmed using MATLAB 15 and applied to the case study. The efficiency of both the model is determined from the load curve and the load is predicted as a testing sample. The ANN model trains the daily load data for a set of days and then forecast the load for next day. Actual data are obtained from "Mankapur Substation" is used to validate the result.

Keywords: Load forecasting; Load demand; Power Quality; MATLAB; Load

1. Abstract

Accurate load forecasting plays a key role in economical use of energy. Artificial Neural Network (ANN) models have been extensively implemented to produce accurate results for short-term load forecasting with time lead ranging from an hour to a week. In this report daily peak load forecasting has been performed for the part of a town supplied by 2 distribution feeders on weekdays by taking into consideration the historical maximum Power consumption in MWH, Voltage in KV and Current in Amp data. Optimization of the network parameters is performed for both learning rules. Energy demand forecasting is of great importance in the management of power systems. In this report artificial neural network technique (ANN) is used for forecasting the load curve. Algorithms using these techniques have been programmed using MATLAB 15 and applied to the case study. The efficiency of both the model is determined from the load curve and the load is predicted as a testing sample. The ANN model trains the daily load data for a set of days and then forecast the load for next day. Actual data are obtained from "Mankapur Substation" is used to validate the result.

2. Introduction

Electric load forecasting is the process used to forecast future electric load, given historical load, weather information along with current and forecasted weather information. There is a growing tendency towards unbundling the electricity system. This is continually confronting the different sectors of the industry (generation, transmission, and distribution) with increasing demand on planning management and operations of the network. Load forecasting plays a key role in helping an electric utility to make important decisions on power, load switching, voltage control, network reconfiguration, infrastructure development, purchasing and generating electric power, load switching, and infrastructure development. Load forecasts are extremely important for energy suppliers, ISOs, financial institutions, and other participants in electric energy generation, transmission, distribution, and markets. Load forecasting is however a difficult task because the load series is complex and exhibits several levels of seasonality systems. Daily maximum load forecasting is used for the applications like the unit commitment, security analysis of the system and the economical scheduling of the outages and fuel supply. Artificial Neural Network (ANN) is mostly used for the prediction of the load. The reason is, ANN methodology solves the complex relationships between the independent and dependent variables by a mathematical mapping algorithm. Short-term load forecasting (one hour to one week ahead) plays a key role in economic and secure system operation. Short term load forecasting displays a great ability for economic and secure operation of power. In the rapidly growing power markets like India with the limited generation capacity, this can be the powerful tool for the demand side management. Efforts are made in this work to develop, train and test an artificial neural network model which can forecast the peak load to a reasonable accuracy of a smaller area with data knowledge.

3. Artificial Neural Network

ANN is originally developed to mimic basic biological neural systems. An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. Neural networks are essentially nonlinear circuits that have the demonstrated capability to do non-linear curve fitting.

4. ANN forecasting using model

The developed forecasting model, which considers temperature and humidity as input data, is shown in Fig. 1. Since the load demand does not depend only on temperature and humidity and in order to account for other factors, the input data (temperature and humidity) are fed to the neural network with historical load data for training and comparing for future load forecasting.

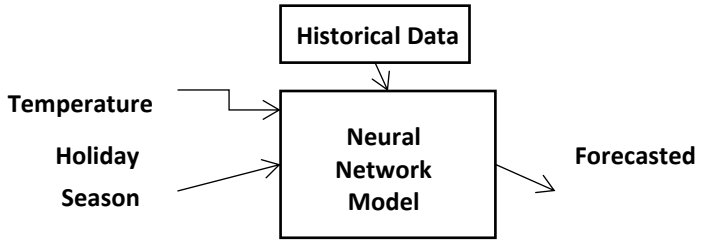


Fig. 1. The proposed ANN models

For non-linear curve fitting problems, neural networks have proved good performance. Neural network results, as an output, in linear or non-linear mathematical functions of the input data. Neural network elements might be arranged in different number of layers between the input and output; however, in practice, the number of used layers is relatively small. ANN uses data to learn the model and then to find the best weights that results in best fitting for the output. After that, new input data are used to forecast future outputs.

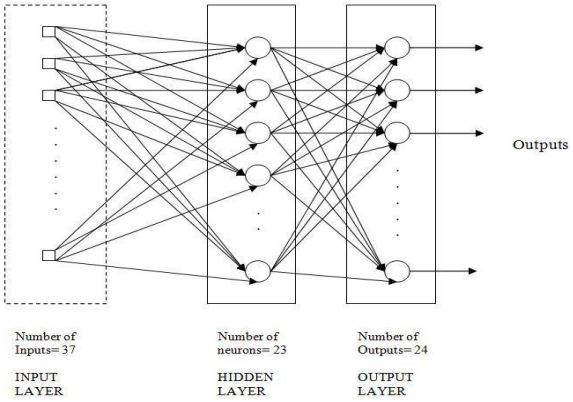
5. Data Collected

All data are collected from Mankapur substation of feeders (Ambajhari-1and Uppalwadi) for the months of June, July and August. The following parameters are considered.

- Maximum Voltage
- Minimum Voltage
- Maximum Current
- Minimum Current
- MWH consumption
- Temperature

6. Load Forecasting using ANN

- Short-term power load forecasting is used to provide utility company management with future information about electric load demand in order to assist them in running more economical and reliable day-to-day operations.
- A broad spectrum of factors affects the system's load level such as trend effects, cyclic-time effects, and weather effects, random effects like human activities, load management and thunderstorms.
- Thus, the load profile is dynamic in nature with temporal, seasonal and annual variations. In our project we developed a system that predicted 24 hours at a time load demand. As inputs we took the past load.
- Input to the ANN are past loads and the output of the ANN is the load forecast for a next day. The ANN was implemented using MATLAB 15. The training algorithm was used which is an adaptive learning algorithm using the epoch method of training. The number of epochs while training was set by which point the network was sufficiently trained.



7. Implementation

- Gathering and arranging the data in MS Excel spreadsheet.
- Tagging the data into groups.
- Analyse the data.
- MATLAB simulation of data using ANN.

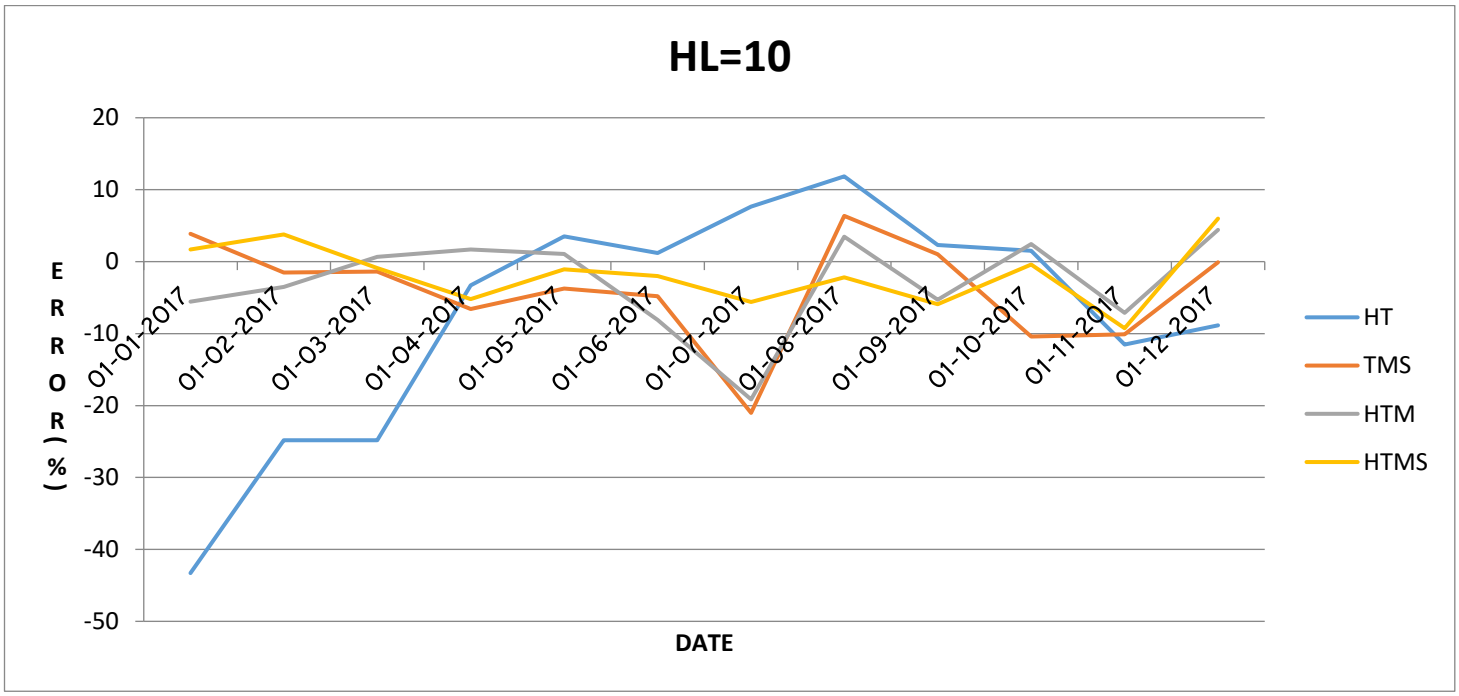
8. Steps for MATLAB simulation

- Type nnstart in MATLAB
- Select Fitting App (nftool)
- Create a variable input.
- Create a variable target.
- Select matrix rows
- Click next, next,
- Click train

- Click next
- Click next and then Simulink diagram.
- Put input values in X1 and run the Simulink.
- Open Y1 to see the output.
- Save Simulink model.

Date	AMBAJHARI-I								
	HL=10								Actual
	HT	Error (%)	TMS	Error (%)	HTM	Error (%)	HTMS	Error (%)	
02-01-2017	1142	-43.2873	766.2	3.8644918	841.2	-5.545797	783.6	1.6813049	797
01-02-2017	1126	-24.8337	915.7	-1.518847	933.6	-3.503326	868	3.7694013	902
01-03-2017	1282	-24.8296	1041	-1.3631938	1020	0.6815969	1036	-0.8763389	1027
01-04-2017	1471	-3.30056	1518	-6.6011236	1400	1.6853933	1498	-5.1966292	1424
01-05-2017	1371	3.518649	1474	-3.7297678	1406	1.0555947	1436	-1.0555947	1421
01-06-2017	1331	1.187825	1412	-4.8255382	1456	-8.092056	1374	-2.0044543	1347
01-07-2017	1085	7.659574	1422	-21.021277	1400	-19.14894	1541	-31.148936	1175
01-08-2017	1220	11.84971	1296	6.3583815	1336	3.4682081	1414	-2.1676301	1384
01-09-2017	1220	2.321857	1236	1.0408327	1315	-5.284227	1323	-5.9247398	1249
01-10-2017	1287	1.530222	1443	-10.405509	1275	2.448355	1312	-0.3825555	1307
01-11-2017	1084	-11.5226	1070	-10.082305	1041	-7.098765	1062	-9.2592593	972
01-12-2017	1043	-8.87265	958.8	-0.0835073	915.7	4.4154489	900.7	5.9812109	958

9. Graphs for better comparison of Ambajhari-I



10. Conclusion

The historical data of previous year (2017) is collected from Mankapur substation and physical parameters like Temperature, Season, Holiday etc are used for analysis and this data is used in MATLAB simulation and results are obtained.

11. Future Work

Using this data and MATLAB simulation using ANN, we can analyse the electrical parameters of next month and this can be used in generating station for required generation of power and the effect of temperature and season can be determined.

12. References

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