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Two Day Ahead Short Term Load Forecasting Neural Network Based

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***Abstract*—**This paper presents an Artificial Neural Network based approach for short-term load forecasting and exactly for two days ahead. Two seasons have been discussed for Iraqi power system, namely summer and winter; the hourly load demand is the most important input variables for ANN based load forecasting. The recorded daily load profile with a lead time of 1-48 hours for July and December of the year 2012 was obtained from the operation and control center that belongs to the Ministry of Iraqi electricity.

The results of the comparison show that the neural network gives a good prediction for the load forecasting and for two days ahead.

***Keywords*—**Short-Term Load Forecasting, Artificial Neural Networks, Back propagation learning.

I. Introduction

LOAD forecasting is one of the important and essential functions in the power systems operations and it is extremely important for energy suppliers, financial institutions, and other participants involved in electric energy generation, transmission, distribution, and supply. Load forecasts can be divided into three categories: short-term forecasts, medium-term forecasts and long-term forecasts. Short Term Load Forecasting (STLF) is an important part of the power generation process. Previously it was used by traditional approaches like time series, but new methods based on artificial and computational intelligence have started to replace the old ones in the industry, taking the process to newer heights.

Artificial Neural Networks are proving their supremacy over other traditional forecasting techniques and the most popular artificial neural network architecture for load forecasting is back propagation. This network uses continuously valued functions and supervised learning i.e. under supervised learning, the actual numerical weights assigned to element inputs are determined by matching historical data (such as time and weather) to desired outputs (such as historical loads) in a pre-operational "training session". The model can forecast load profiles from one to seven days.[1]

From 1990, researchers began to implement different approaches for STLF other than statistical approach. The emphasis shifted to the application of various AI techniques for STLF. AI techniques like Neural Network (NN), Fuzzy NN (FNN), and Expert Systems have been applied to deal with the non-linearity, huge data sets requirement in implementing the STLF systems and other difficulties in modeling of statistical methods used for application of STLF [2], [3].

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II. Artificial Neural Networks

A. Introduction

Artificial Neural Networks (ANNs) are a data processing system consisting of a large number of simple, highly interconnected processing elements inspired by the biological system and designed to simulate neurological processing ability of human brain [4]. A generic artificial neural network can be defined as a computational system consisting of a set of highly interconnected processing elements, called neurons, which process information as a response to external stimuli. An artificial neuron is a simplistic representation that emulates the signal integration and threshold firing behavior of biological neurons by means of mathematical equations [5]. An artificial neuron and its model is shown in Fig. 1.

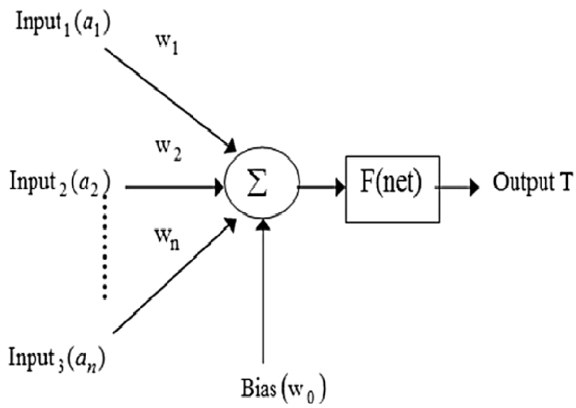

Fig. 1 The basic model of an artificial neuron

B. Proposed Back Propagation Neural Network

To date, there exist many types of ANNs which are characterized by their topology and learning rules. As for the STLF problem, the BP network is the most widely used one. With the ability to approximate any continuous nonlinear function, the BP network has extraordinary mapping (forecasting) abilities. The BP network is a kind of multilayer feed forward network, and the transfer function within the network is usually a nonlinear function such as the sigmoid function. The typical BP network structure for STLF is a three-layer network, with the nonlinear Sigmoid function as the transfer function [6], [7].

The proposed Multi Layer perceptron MLP for the Iraqi power system, is a combination of 3 inputs, 10 hidden layers and 1 output and as shown in Fig. 2.

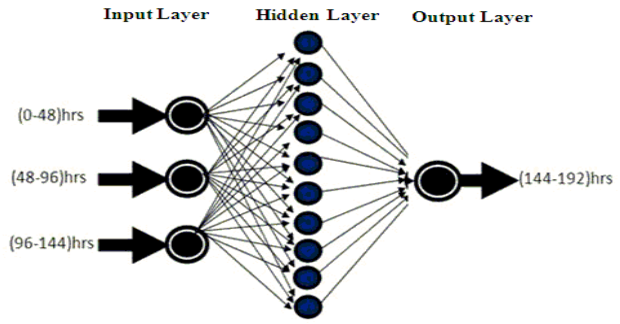

Fig. 2 Proposed MLP for Iraqi Power System

III. Input Variables

The input variables highly affect the result of the load demand forecasting. Input variables are commonly selected from historical load, which takes the temperature in view. The load historical input variables are consisted of three inputs each of 48 hourly actual load data (two days) for the two seasons, summer and winter of 2012, namely July (from 16 July - 21 of July will be the inputs and 22- 23 of July will be the outputs) as shown in Fig. 3, and December (from 22 Dec. - 27 Dec. will be the inputs while 28-29 Dec. will be the outputs) as shown in Fig. 4.

The selection of July and December to represents summer and winter, was chosen to be the highest loads in Iraq for these two seasons. The actual load demand data for summer and winter will be given in Tables I & II respectively:

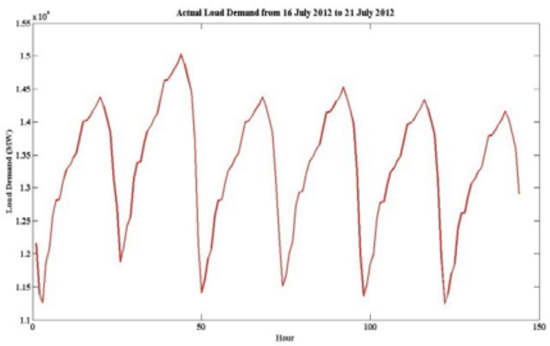

Fig. 3 Summer 2012 actual load demand

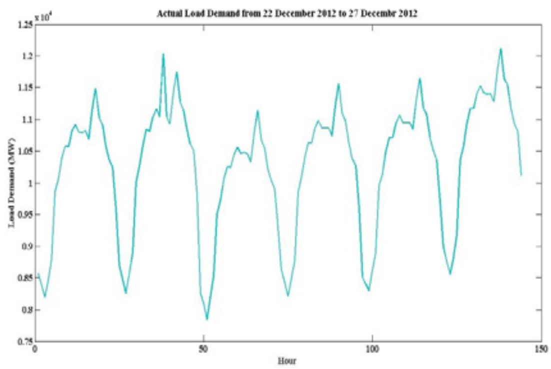

Fig. 4 Winter 2012 actual load demand

TABLE I
Iraqi Power System Actual Load Demand from 16-23 July of 2012

Daily Hours	16 July & 17 July	18 July & 19 July	20 July & 21 July	22 July & 23 July
01	12240	12154	12000	12158
02	11429	11418	11365	11394
03	11665	11608	11533	11261
04	11951	11932	11849	11886
05	12115	12092	11994	12071
06	12662	12573	12540	12585
07	12906	12815	12782	12819
08	12911	12821	12787	12825
09	13170	13077	13043	13081
10	13362	13269	13234	13273
11	13436	13342	13307	13346
12	13547	13452	13417	13456
13	13619	13524	13488	13528
14	13861	13765	13729	13769
15	14100	14002	13965	14006
16	14114	14015	13978	14019
17	14180	14081	14044	14085
18	14276	14177	14139	14181
19	14350	14251	14213	14255
20	14481	14380	14342	14384
21	14338	14238	14201	14242
22	14149	14051	14013	14045
23	13936	13840	13813	13843
24	13202	13124	13102	13128
25	12342	12272	11970	12698
26	11583	11513	11245	11881
27	11786	11669	11404	12090
28	12100	12008	11707	12421
29	12318	12182	11854	12572
30	12814	12745	12403	13135
31	13013	12939	12621	13388
32	13019	12945	12626	13393
33	13280	13204	12878	13662
34	13474	13397	13067	13861
35	13549	13471	13139	13938
36	13661	13582	13248	14053
37	13734	13654	13318	14128
38	13979	13898	13555	14380
39	14219	14137	13788	14627
40	14233	14151	13802	14641
41	14300	14217	13867	14710
42	14397	14314	13961	14804
43	14472	14388	14034	14887
44	14604	14529	14161	15022
45	14460	14376	14021	14874
46	14269	14187	13817	14667
47	14068	13972	13601	14460
48	13328	13251	12915	13710

TABLE II
IRAQI POWER SYSTEM ACTUAL LOAD DEMAND FROM 22-29 DECEMBER OF 2012

Hours	22 Dec. & 23 Dec.	24 Dec. & 25 Dec.	26 Dec. & 27 Dec.	28 Dec. & 29 Dec.
01	8575	8259	8516	8509
02	8385	8084	8400	8284
03	8196	7840	8298	8091
04	8466	8196	8623	8401
05	8802	8529	8898	8802
06	9860	9509	9956	9746
07	10055	9720	10131	9978
08	10381	10062	10505	10294
09	10572	10250	10713	10489
10	10567	10242	10713	10509
11	10816	10443	10947	10678
12	10907	10556	11064	10779
13	10792	10460	10947	10678
14	10792	10483	10947	10652
15	10815	10454	10947	10668
16	10685	10331	10843	10567
17	11138	10778	11317	11021
18	11485	11137	11652	11373
19	11026	10675	11183	10936
20	10919	10549	11075	10845
21	10571	10206	10716	10512
22	10356	10028	10520	10305
23	10243	9910	10368	10194
24	9595	9297	9718	9688
25	8702	8625	8990	8783
26	8468	8429	8749	8576
27	8262	8209	8552	8382
28	8556	8493	8826	8684
29	8912	8777	9181	8988
30	10018	9859	10358	10132
31	10268	10088	10574	10326
32	10581	10401	10937	10692
33	10844	10626	11167	10880
34	10805	10626	11167	10884
35	11040	10858	11414	11116
36	11158	10974	11527	11211
37	11040	10858	11410	11103
38	12040	10858	11397	11086
39	11043	10858	11397	11131
40	10922	10742	11276	10985
41	11398	11206	11764	11452
42	11749	11554	12128	11841
43	11284	11090	11644	11410
44	11146	10974	11534	11298
45	10846	10626	11155	10927
46	10606	10381	10921	10649
47	10503	10277	10813	10561
48	9808	9607	10117	9902

IV. EXPERIMENTS AND RESULTS

The proposed model derived the input variables from the historical hourly dataset of Iraqi power system during the year of 2012, and it tested on the summer and winter season 2012 with actual data.

In order to evaluate the performance of the load forecasting model, the mean square absolute percentage error (MAPE) is considered to measure the accuracy of the load forecast performance between the actual load data and the forecasted load data.

The MAPE is defined as follows:

$$MAPE = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{P_{actual\,i} - P_{Predicted\,i}}{P_{actual\,i}}\right] \quad (1)$$

where P_{actual} is the actual load demand, and $P_{predicted}$ is the forecasted or predicted load data.

A. Summer Forecast

For this case the training will be for the six days (from 16 July to 21 July of 2012) and the prediction will be for the next two days (for 22 & 23 July of 2012) and as given in Table I, Fig. 5 below shows the actual load demand with the predicted one. Fig. 6 shows the neural network training performance for 48 hours (for 22 & 23 July of 2012), Fig. 7 shows the neural network training regression for the same period.

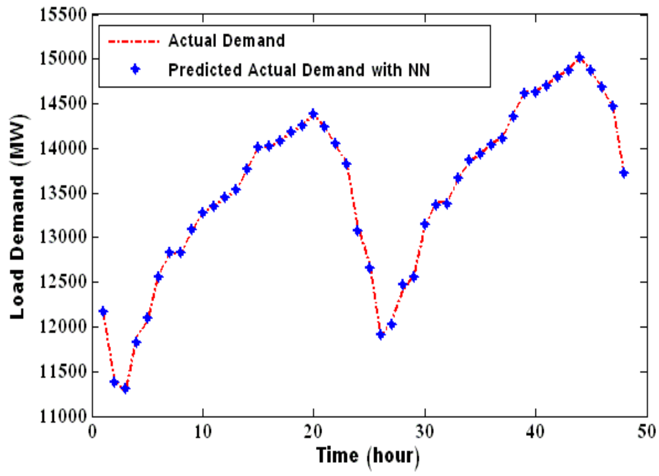

Fig. 5 Actual and predicted load demand for 22&23 July 2012

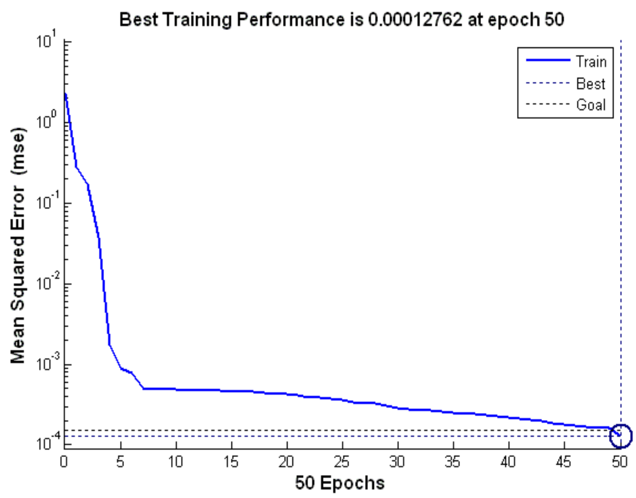

Fig. 6 Neural network training performance for 22&23 July 2012

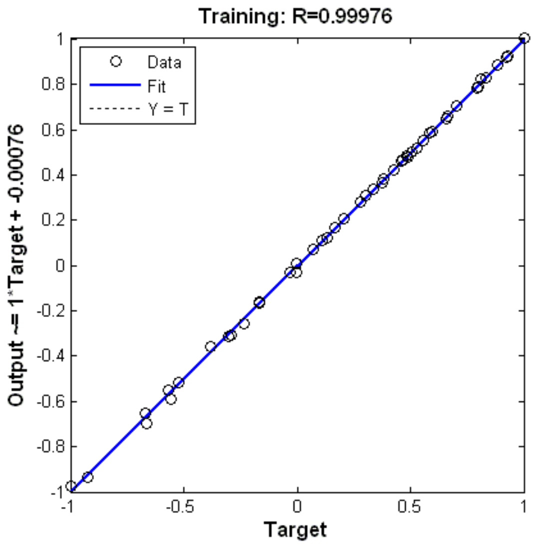

Fig. 7 Neural network training Regression for 22&23 July 2012

B. Winter Forecast

For this case the training will be for the six days (from 22 Dec. to 27 Dec. of 2012) and the prediction will be for the next two days (for 28 & 29 Dec. of 2012) as given in Table II, Fig. 8 below shows the actual load demand with the predicted one. Fig. 9 shows the neural network training performance for 48 hours (for 28 & 29 Dec. of 2012), Fig. 10 shows the neural network training regression for the same period.

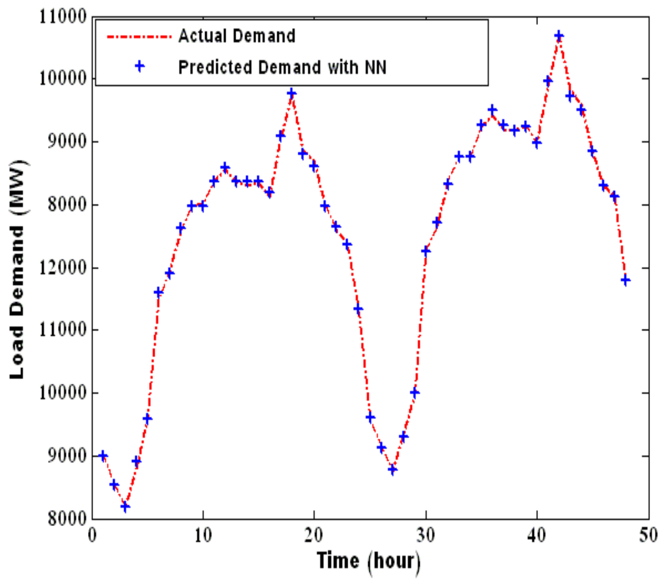

Fig. 8 Actual and predicted load demand for 22&23 July 2012

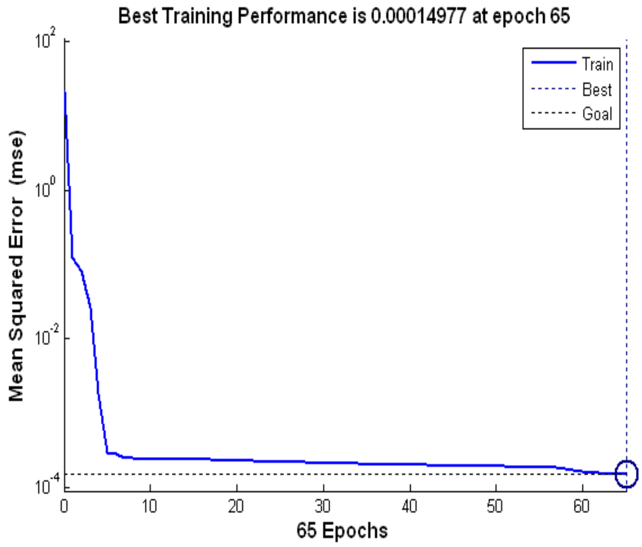

Fig. 9 Neural network training performance for 28&29 Dec. 2012

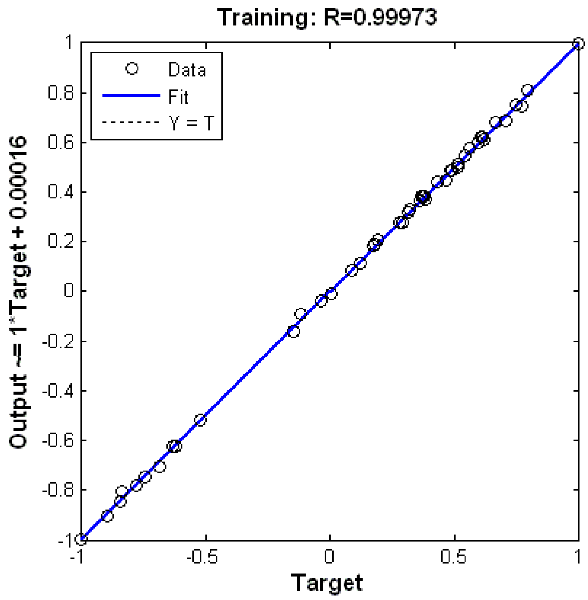

Fig. 10 Neural network training Regression for 28 & 29 Dec. 2012

C. Results Comparison

From the figures shown previously for the two seasons in Iraq, the following table gives a comparison for the application of the neural network on the mentioned seasons:

TABLE III
COMPARISON RESULTS

Season	Summer 2012	Winter 2012
Epoch	50	65
MAPE %	1.3533	1.027
Hidden Layers	10	10
Training Performance	0.00012762	0.00014977
Target Error	0.00015	0.00015

V. CONCLUSIONS

The results of the MLP network model used for two day ahead short term load forecast for Iraqi power system, shows that MLP network has a good performance and reasonable prediction accuracy was achieved for this model.

Its forecasting reliabilities were evaluated by computing the mean absolute error between the exact and predicted values.

The results suggest that ANN model with the developed structure can perform good prediction and finally this neural network could be an important and powerful tool for short term load forecasting.

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