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Short Term Load Forecasting Based on Influencing Factors Using ANN.

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Abstract— Now a days**,** load forecasting has become one of the major areas of research in electrical engineering. STLF(Short term load forecast) is essential for Power system planning and economic load dispatch. A large variety of mathematical methods have been developed for load forecasting. This research presents influencing factors for STLF and an ANN-based short term load forecasting (STLF) model for MGVCL load. It includes ANN model with their comparative errors by using feed-forward network with sigmoid hidden neurons and linear output neurons. The network will be trained with Levenberg-Marquardt back propagation algorithm. In order to investigate the result, have to check the performance of model during training, validation and testing. Our aim is to develop best suited model for MGVCL, by critically evaluating the ways in which the NNs proposed in these research will designed and tested.

Keywords-Short term load forecasting, load patterns, influencing factors, Artificial Neural Network (ANN)

I. INTRODUCTION

Load forecasting is a process in which the aim is to satisfy the loads for a foreseen future. It tells about the scenario of present and future load demand. It has many applications such as energy purchasing and generation, load switching, contract evaluation, and infrastructure development. Accurate load forecasting is very difficult task. First, because the load series is complex Second, the load at a given hour is dependent on the load at the previous day, and previous week.

1.1 TYPES OF LOAD FORCASTING TECHNIQUES

Load forecasts can be widely divided into three categories:

- Short-term forecasts: 1 hour to 1 week.
- Medium forecasts: 1 week to a year.
- Long-term forecasts: Longer than a year.

Load forecasting has always been important for planning and operation, with supply and demand fluctuating and the changes of weather conditions and energy prices widely increasing during peak situations.. Short-term load forecasting is very useful to estimate load flows and to make decisions that can prevent overloading. Timely implementations of such decisions lead to the improvement of network reliability and also reduced occurrences of equipment failures and blackouts.

Consideration of various factors is very essential for accurate forecasting of load. For Short-term load forecasting several factors should be considered

- Time factor
- Weather
- Type of costumer
- Past data

II. LOAD PATTERN

Load patterns are depends on type of load like residential, industrial, agriculture etc. As proper analysis of each load pattern is very much important. It is also different for weekdays, weekends,

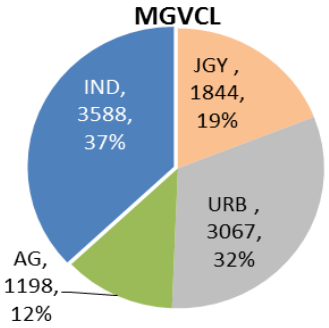
holidays, special events, seasons, etc. Therefore Consideration of various factors is the prerequisite of accurate forecasting..

2.1 LOAD STRUCTURE

This paper proposed a forecast model of MGVCL load. MGVCL total load is combination of domestic load, industrial load, agriculture and JGY as shown in below table.

MONTH	YEAR 2012-2013 data in %				
	JGY	URB	AG	IND	Total
MGVCL	19	32	12	37	100

As shown above total load is combination of 4 types of load, in which 19% load of JGY, 32% of urban load, 12% agriculture load and 37% industrial load. For accurate load forecasting one has to find out various parameters influence to load which is different for different type of cosumers. For example for domestic load change in temperature is highly influence on load demand, but it is less affected for industrial consumer.



Above diagram shows total load of MGVCL which is combination of URB (Domestic Load)-32%, JGY (Jyoti Gram)-19%, IND (Industrial Load) 37%, AG (Agriculture Load) 12%.

2.2 LOAD PATTERN ANALYSIS

Forecasted load 1.1.14	Actual	Diff.	Forecasted Load 2.1.14	Actual	Diff.
916	924	-8	965	913	52
909	913	-4	949	892	57
902	915	-13	930	887	43
902	900	2	931	883	48
898	894	4	929	888	41
944	932	12	969	923	46
1039	991	48	1053	1018	35
1091	1034	57	1113	1076	37
1135	1083	52	1132	1078	54
1178	1156	22	1184	1141	43
1220	1184	36	1212	1188	24
1197	1199	-2	1208	1174	34
1199	1151	48	1187	1158	29
1180	1129	51	1168	1139	29
1174	1149	25	1179	1129	50
1180	1098	82	1147	1111	36

1170	1120	50	1143	1115	28
1198	1156	42	1167	1118	49
1230	1206	24	1231	1197	34
1206	1156	50	1192	1125	67
1177	1075	102	1104	1055	49
1080	1028	52	1049	1037	12
995	1000	-5	1011	980	31
982	930	52	983	943	40

Table: 2 Actual load and forecasted load of 1st, 2nd January 2014

After verification of actual load and forecasted load we identify that difference between actual load and forecasted load is highly non-linear.

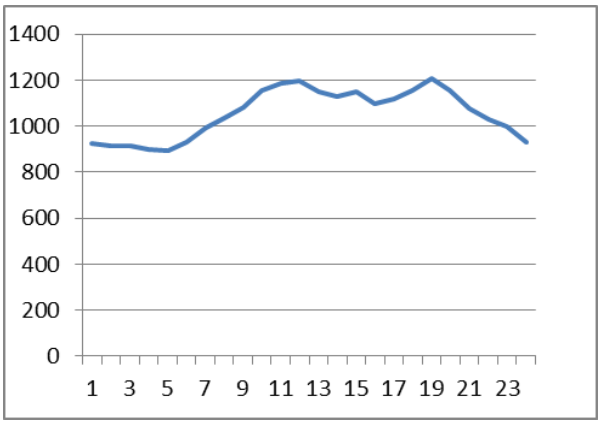


Fig.1 (a) Load curve of 1st January 2014

In Fig. 1(a) hourly load curves is shown for 24 hours of a day. The interval length is one hour, so there are 24 intervals in the figure. It can be seen in figure that the load is low and stable from 12 midnight to 6 am, the load start rising at 7 o clock till 9 am and then it is flattened till 12 am and after that it descends till 5 pm (17:00 in figure) and after 5 pm it start rising till 8 pm (19:00), after 8 pm load gradually decrease until the end of the day.

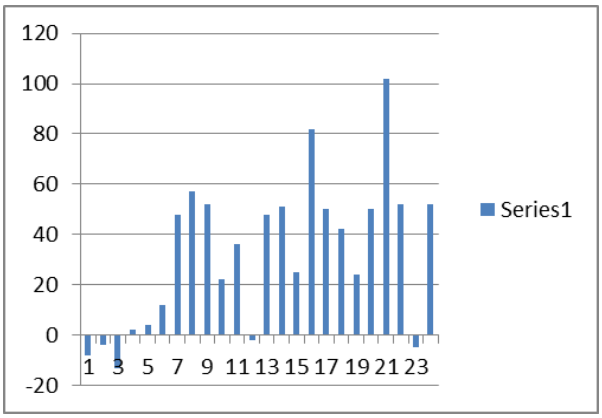


Fig 1(b) Error plot for 1st January 2014

As shown in fig 1 (b) error between actual load and forecasted load of 1st Jan 2014 is varying with respect to time. Error is less till 6 a.m. highest at 8 p.m. which is 102 MW.

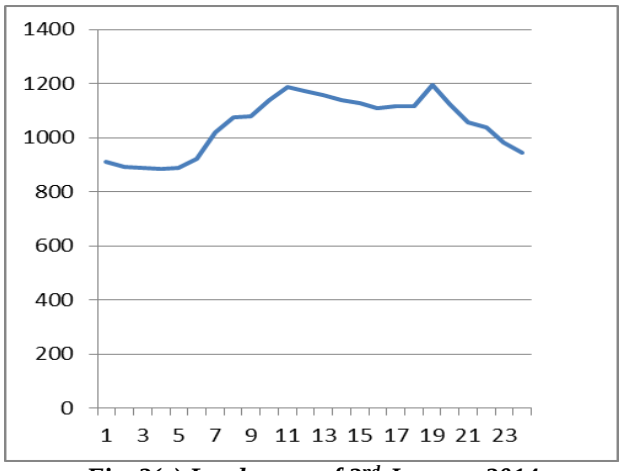


Fig. 2(a) Load curve of 2nd January 2014

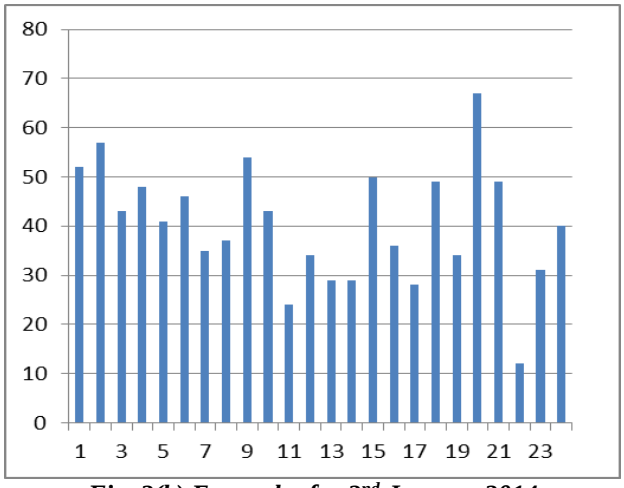


Fig. 2(b) Error plot for 2nd January 2014

As shown in fig 2 (b) error between actual load and forecasted load of 2nd Jan 2014 is varying with respect to time. Minimum error occur at 10 p.m. and highest error at 8 p.m.

III. INFLUENCING FACTORS

- Time Factor

From the above discussion one can conclude that time is very important parameter for load forecasting. Load is highly depending on time slot of the day. After analyzing various load pattern one can observed that load pattern of similar day is almost same as shown below.

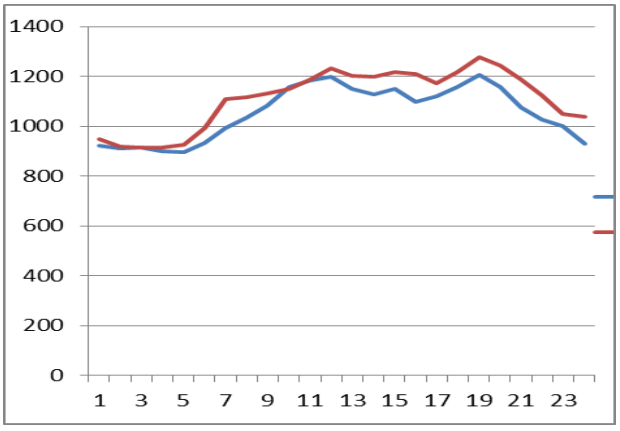


Fig 4 Load pattern of Wednesday January 2014

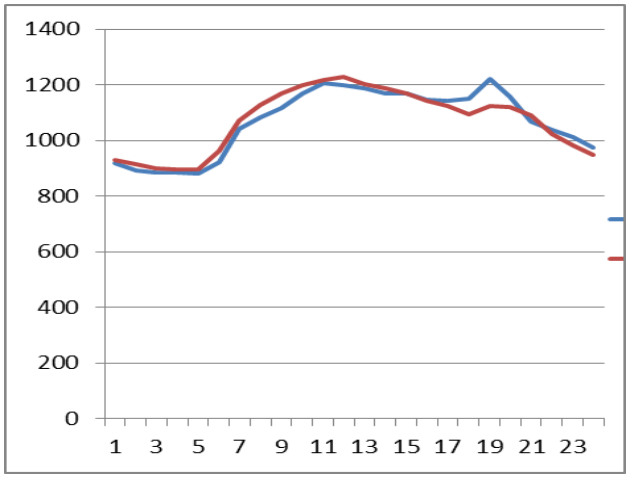


Fig 5 Load pattern of Monday January 2014

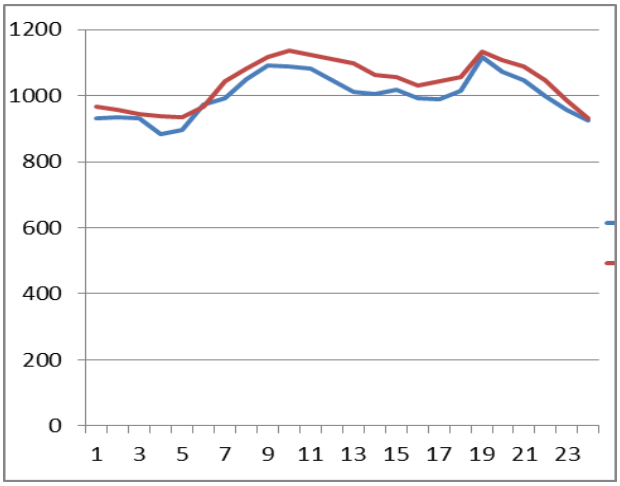


Fig 6 Load pattern of Sunday January 2014

Fig 4,5, and 6 shows the load pattern of Wednesday, Monday and Sunday of the month of January 2014, which is almost same.

- Economic Factor

Since electricity became people's daily life necessity. Economy of the state has also an impact on the usage of electricity. Economic factor has more importance in long term forecasting (LTLF), but it also can impact the load curve for short term load forecasting(STLF).

- Weather

Weather is the most important independent variable for short term load forecasting. The effect of weather is most prominent for domestic and agricultural load, but it can also alter the load profile of industrial consumers. Load forecasting models use weather forecast and other factors to minimize the operational cost.

- Random Spikes

As MGVCL load is combination of various load like domestic, industrial, agriculture and jyoti gram. Generally domestic load follows statistical rules, but industrial load and agriculture load is highly non linear. Sudden start up and shut down of industrial load will produce drastic change in load demand. Same way agriculture load is highly depends on weather conditions like temperature and rain. All this load changes are random in nature.

IV. ADVANCED APPROACH

- Artificial Neural Network

ANN are extremely powerful computational devices. Massive parallelism makes them very efficient having outstanding ability to derive meaning from complicated data, neural networks can be applied to detect or extract highly complex patterns and trends. Neural network architecture can be broken down into two main categories:

- Feed forward neural network which consists of single-layer or multi-layer networks, and
- Feedback (recurrent) neural network

This is in opposition to the former. Feed forward ANN was the first simplest type of neural network. The information travels in only one direction, forward, from input nodes to output nodes. There are no feedbacks in the network, which means the output of any layer does not affect that same or previous layer. Figure 1 shows a simple feed forward artificial neural network. It is composed of three layers of computational units: a layer of input units, a layer of hidden units, and a layer of output units. Each neuron in one layer has directed connections to the neurons of the subsequent layer. The hidden neuron is typically modeled with a nonlinear sigmoid activation function. It also can be modeled with other activation functions to constitute other types of neural networks. Feedback is said to exist in a dynamic system whenever the output of an element in the system influences in part the input applied to that particular element, thereby producing one or more closed paths for the transmission of signals around the system. Feedback networks are dynamic; their states are changing continuously until they reach an equilibrium point. Once the input changes, the states leave the equilibrium point and a new equilibrium needs to be found.

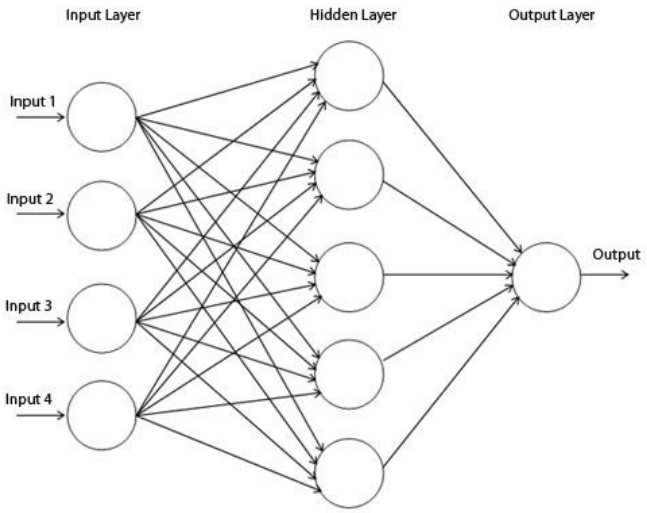


Fig:7 Basic Neural Network Model

V. SIMULATION RESULT:

Implementation of ANN using MATLAB.10

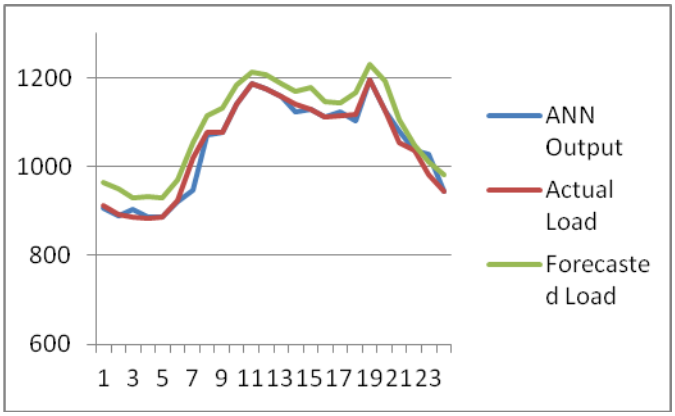


Fig:8 Comparison of ANN output and forecasted data with actual load

As shown in fig 8 ANN output is closely match with actual load demand.

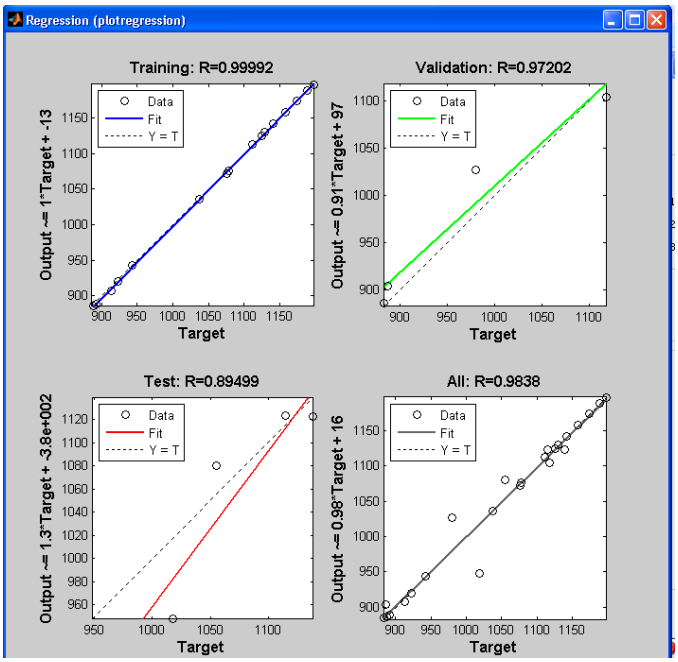


Fig : 9 Regression plot of ANN Model

Regression R Values measure the correlation between outputs and targets. An R value of 1 means a close relationship, 0 a random relationship. As shown in fig 9 value of regression during training is 0.999, during validation 0.972 and during testing 0.894.

VI. CONCLUSION

As load behavior is highly non-linear, affected by various influencing factors. It is very difficult to predict the load accurately using analytical method. In this paper, a new neural network approach for short-term load forecasting is proposed.

A load forecasting model designed using Matlab ANN Toolbox. The implementation of the network architecture, training of the Neural Network and simulation of test results were all successful with a very high degree of accuracy resulting into 24 hourly load output. In future one can implement this method to gain higher accuracy.

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