Load Forecasting for Demand Side Management for Smart Grid Using ANN

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***Abstract*—Load forecasting plays a significant role in the field of power system in many aspects. High Degree of accuracy is required in load forecasting to calculate accurate information related to power generation required to consumers and consumption by consumers take place in electricity markets. Forecasting is beneficial for maintain stability, quality of electricity reached to consumers in reasonable price. As it is very obvious load and demand frequently vary at power station due to many reasons. In this paper for maintaining the power system demand should forecast using ANN. ANN is designed to solve complex problem, it is design to imitate function and structure of the brain.**

***Index Terms*—ANN(Artificial Neural Network), Load forecasting.**

I. INTRODUCTION

The role of demand side management is an important aspect of the smart grid for load forecasting, lowering the cost of power usage in the smart grid. The important function of DSM is to reduce the peak load demand of energy suppliers. It emphasizes the need to schedule the user's load. To improve DSM, the demand-side end-users are involved in the load planning process in advance. This enables short-term load forecasting (STLF) to be supplied utilizing end-user local knowledge that load aggregators typically lack [1]. To bridge the gap between a previously declared load profile and actual usage, local load management capabilities employ a variety of strategies.

The activities related to planning, implementation and monitoring of power utilities are included in Demand-Side Management (DSM) programs. This encourages consumers to understand and modify their levels and electricity usage patterns. The fundamental goal of most DSM initiatives was to provide cost-effective energy and capacity resources, such as generation facilities, power procurement, and improved transmission and distribution efficiencies, in order to eliminate the need for new electrical sources

II.ARTIFICIAL NEURAL NETWORK

A. Review Stage

An artificial neural network (ANN) is a data processing paradigm based on biological nervous systems, consisting of a large number of closely connected processing components known as neurons [5]. An artificial neural network (ANN) is trained for a specific task, such as pattern recognition or data classification.

ANN is capable of extracting meaning from complex or inaccurate data. Adaptive learning, real-time operation,extract patterns and discover trends that are too complicated for humans or other computer techniques to notice.

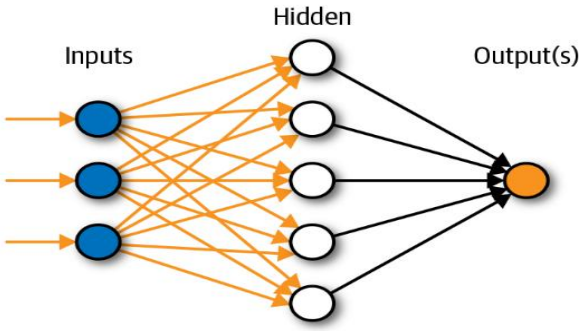


Fig 1: Architecture of Neural Network

A neural network is the biological nervous system's counterpart; it can learn and hence be trained to identify solutions, recognise patterns, classify data, and forecast future occurrences. The way a neural network's various computational parts are connected, as well as the strength of those connections or weights, determine its behaviour [1]. The weights are adjusted automatically by training the network according to a set of learning rules until it completes the task appropriately.

III. MODELLING AND SIMULATION OF ANN BASED FORECASTING

ANN can operate nonlinear & complex problem with astonishing characteristics of the statistical and modeling capabilities. Complicated problem such as relationship between the input and problem to forecast the load situation target is nonlinear. Solution is only ANN to apply into the problem. A simulation has been performed for forecasting of the load using the data shown in the figure 2.

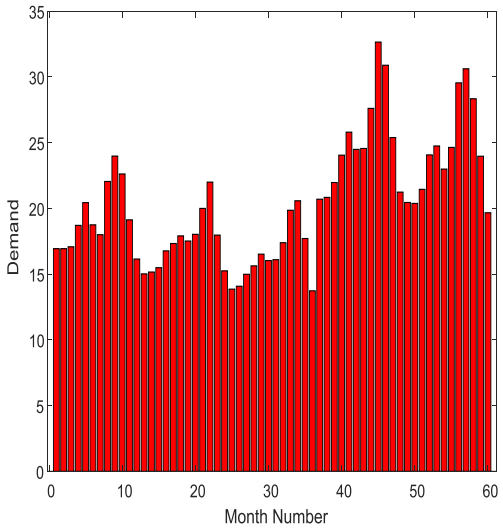


*Fig 2: ATypical graph of monthly demand of user in the one sector of Indore district (demand in MU)*For load forecasting, ANN may work on various network types such as feed forward back propagation, Layer recurrent & feed-forward time delay, and so on. Feed forward network used which come under back propagation in neural network with continuously value function & supervised learning. In order to improve the power system, input data and output data must be matched in a proper manner.

IV. RESULT OF DEMAND FORECASTING USING ANN

In this various data used to train the network, to get better result two to three month data used as input to get forecasted values of demand. And in this way we can use next two month data for forecasting and can achieve better result.

A. Training using ANN

In this figure 3 four input means previous four month data is used for forecasting. This architecture of neural network is used for demand forecasting so that better result can achieve. In this training L1 regulation is used to track data and test the result and can be train again and again to get better result[4]. After providing training and perform it again and again result are always same so in this way our network is reliable also.

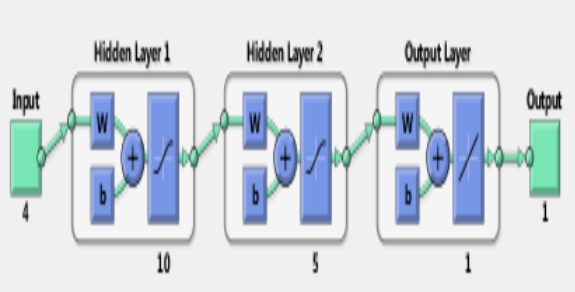


Fig 3: Neural network architecture for forecasting the monthly demand based on previous 4 month demand data

The prior power load consumption with varied sample delays and the current load state are the Neural Network's inputs. The anticipated value of load consumption with the help of the system is the ANN's output.

V. RESULT AND CONCLUSION

In figure 4 graph is shown of training performance of neural network with L1 regulation. On Y-axis mean squared error and on X- axis epoch is taken. Blue line is actual data line which provided training and red line shows the predicted data and green line is validation line to achieve result. Here at 6.9922 at epoch 30 best validation performance is shown.

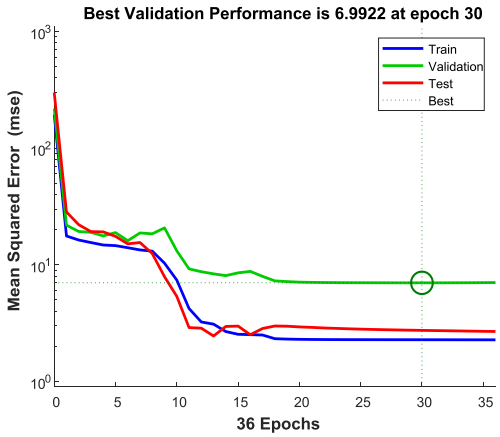


Fig 4: Training Performance of the neural network with L1 regulation

In this plot (figure 5) regression analysis of each data can be seen clearly. Here graph plottedbetween target

(actual data) and output after training and in next graph of validation where regression is 0.88088. Then testing of data and after that overall graph with regression 0.9278 is achieved.

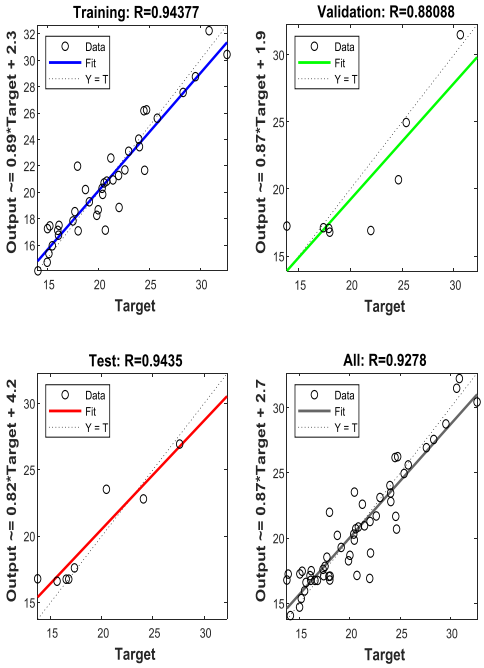
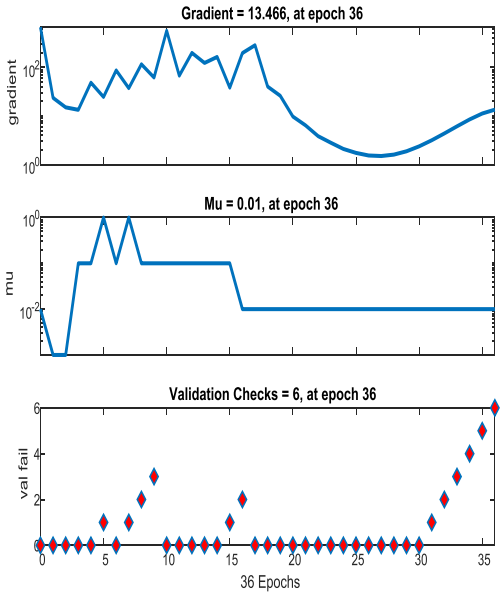


Fig 5 : Regression analysis of training results of the neural network

The Plot shown in below is the training parameter variation during the training of neural network. In this it is observed how parameter change radiation and how micro unit (Mu) is changed.



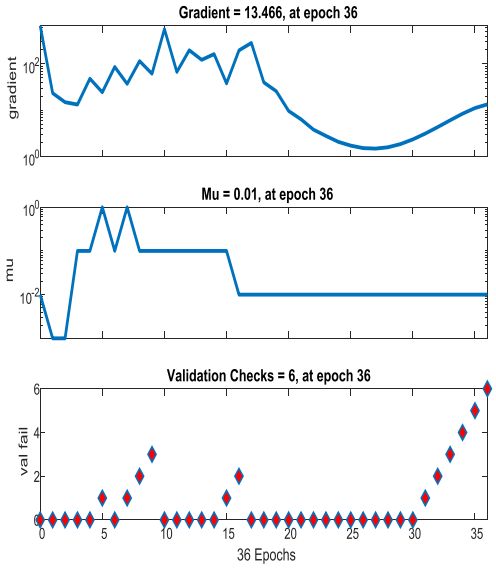


Fig 6: Training parameters variation during the training of the neural network

Finally after data is provided as input then training using neural network and after viewing many plot and graph final result obtain in the figure 6 typical graph of demand forecasting with respect to actual demand in Mu. The pink line shows the Actual demand on station and black line shows the predicted demand.

Result is very clear to maintain the demand on the power station and it is easy to resolve the problem by predicted data. It is also beneficial to economy of India and serve the customers in better way. The problem can be solved of generation of electricity if data is already predicted then only predicted data can be generated so provided to consumer in efficient and reducing price also as more energy is saved after forecasting data. In this way system becomes stable and more reliable.

REFERENCES

[1] SamsherKadirSheik, M. G. Unde, "SHORT-TERM LOAD FORECASTING USING ANN TECHNIQUE" International Journal of Engineering Sciences & Emerging Technologies, Feb 2012 ISSN: 2231 6604 Volume 1, Issue 2, pp: 97-107.

[2] Gross G., Galina F.D. 1987. Short Term Load Forecasting. Proceedings of IEEE. 75(12): 1558-1573.

[3] Khaparde S.A., Lohitha A., Desai. 1991. U.B. Load forecasting using ANN. IEEE Tencon. 91:

208-212

[4] G. Gross and F.D. Galina. 1987. Short Term Load Forecasting. Proceedings of IEEE. 75(12): 1558-1573.

[5] H. Mori and A. Yuihara. 2001. Deterministic annealing clustering for ANN-based short-term load forecasting. IEEE Transactions on Power Systems. 16: 545-551.

[6] M Haykin S. 2000. Neural Networks: A comprehensive survey. Pearson Education, India.

[7] C. Joe-Wong, S. Sen, H. Sangtae, and C. Mung, "Optimized day-ahead pricing for smart grids with device specific scheduling flexibility," IEEE J. Sel. Areas Communication, 2012.

[8] Ishan Gupta, G.N. Anandini, Megha Gupta "An Hour wise device scheduling approach for Demand Side Management in Smart Grid using Particle Swarm Optimization" IEEE conference in IIT Kanpur,2016

[9] Mohamed E. El-Hawary "The Smart Grid—State-of-the-art and future trends" Eighteenth international conference in Middle East power systems in Cairo, Egypt (MEPCON) IEEE ISSN 978-1-4673-9063-7 December 27-29, 2016.

[10] NidhiGoel, Megha Agarwal "Smart grid networks: A state of the art review" International Conference on Signal Processing and Communication Noida, India (ICSC) ISBN 978-1-4799-6761-2 March 16-18, 2015.

[11] Noelia Uribe-Pérez, Luis Hernández , David de la Vega and Itziar Angulo "State of the Art and Trends Review of Smart Metering in Electricity Grids" Applied Science MDPI Journal February 29,2016.

[12] NurAsyikHidayatullah, Akhtar Kalam "State of the Art Distributed Generation and Smart Grid Technologies: A Review and an Analysis the Impacts of Distributed Generation (DG) on Smart Grid (SG) system LAP LAMBERT Academic Publishing ,ISBN 978-3848495719 April 6, 2012.

[13] Rosario Miceli, Salvatore Favuzza, Fabio Genduso "A Perspective on the Future of Distribution: Smart Grids, State of the Art, Benefits and Research Plans" Energy and Power Engineering, Scientfic Research Publication Year 2013.

[14] Andrea M. Tonello, Jian Song, Stephan Weiss, Fang Yang "PLC for the Smart Grid: State-of-the-Art and Challenges" Proceedings 4th International Conference on Communications, Mobility and Computing Year 2012.

[15] Antonio Colmenar-Santos, Migue-ÁngelPérez, David Borge-DiezClara Pérez-Molina "Reliability and management of isolated smart-grid with dual mode in remote places: Application in the scope of great energetic needs" ELSEVIER International Journal of Electrical Power & Energy SystemsVolume 73, , Pages 805-818 June, 23 2015.

[16] KhosrowMoslehi, Ranjit Kumar "A Reliability Perspective of the Smart Grid" IEEE Transaction on Smart Grid **ISSN:** 1949-3061 May 27, 2010

[17] Ramakrishna Kappagantu, S. Arul Daniel "Challenges and issues of smart grid implementation: A case of Indian scenario" Science Direct Journal of Electrical Systems and Information Technology January 5,2018

[18] Akhil Joseph "Smart Grid and Retail Competition in India: A Review on Technological and Managerial Initiatives and Challenges" Published by Elsevier Ltd SMART GRID Technologies, August 6-8, 2015.

[19] Bimal K. Bose "Artificial Intelligence Techniques in Smart Grid and Renewable Energy Systems—Some Example Applications" Proceedings of the IEEE Volume: 105, Issue: 11, ISSN: 1558-2256 Nov. 2017.

[20] YaserSolimanQudaih, YasunoriMitani "Power Distribution System planning for Smart Grid Applications Using ANN" ICSGCE 2011 Published by Elsevier Ltd, Chengdu, China September 27–30 , 2011.

[21] He Chena, Kai Fengb, QuanZhangb, ZichenZhaob, Lin Zhangc, Jun Lic, KeheWud "Investment Evaluation System Development Based on Unified Information Platform for Future Smart Grid" ICSGCE 2011, Published by Elsevier Ltd Chengdu, China September 27–30 2011.

[22] A.J. Lopes, R. Lezama, R. Pinedaa "Model Based Systems Engineering for Smart Grids as Systems of Systems" Procedia Computer Science page 441–450 year 2011