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Medium Term Load Forecasting using Time Series Regression and Fuzzy Logic for the State of Assam

Suranjana Bharadwaj[1], Chandrika Narzary[2], Meraj Hussain[3], Mirmili Hansepi[4], Santanu Dutta[5]

Assistant Professor, Dept. of EE, Girijananda Chowdhury Institute of Management and Technology, Guwahati, Assam, India[1]

B.Tech Final Year Student, Dept. of EE, Girijananda Chowdhury Institute of Management and Technology, Guwahati, Assam, India[2,3,4,5]

ABSTRACT: An efficient forecast of power demand is a vital part of power system planning and operation. With the ever increasing demand for electrical energy in today's world, it has become a challenging task to cope up with the demand. Hence a strong and efficient planning strategy is required to be adopted by power engineers that ensure both reliability and continuity of power supply to its consumers. In this paper load forecasting is done for the state of Assam using Simple Average, Moving Average and Time Series Regression(ARIMA) method and a comparative analysis is done for these methods. Also, a fuzzy logic controller has been designed for error minimization.

KEYWORDS: Forecast, Demand, Load, Average, Regression, Fuzzifier, Rules, Membership Function etc.

I.INTRODUCTION

For any county whether a developed or a developing one, electricity is an indispensable part of people's life. Electricity has emerged as the main key factor for the overall development of the country. To ensure this, continuous and reliable supply of electricity must be ensured, hence the process of load forecasting came to exist. Now a days, load forecasting has become a vital process in the planning and operation of power system. An accurate forecast makes the system more reliable, saving a considerable amount of operating and maintenance cost, also predicts the necessity of future generation capacity installations. Another aspect of forecasting lies in the importance it holds for the utility companies. The accurate forecast data for different time periods help people at the load dispatch centres to make better decisions, avoiding possible loss of load or blackouts.

II.METHODOLOGY

Medium term load forecasting which generally lasts from a week to a year is important for fuel reserve planning and unit commitment. There are various available methods for carrying out medium term load forecasting. In this paper, a comparative analysis has been made among**Simple Average** method**, Moving Average** method and the **Regression based ARIMA** model. Further error analysis has been done with the help of a **Fuzzy Logic Controller.**

(i) Simple Average: It is a very basic method and in most of the cases inefficient. Only in certain cases it comes handy when the error is less and demand is more or less same for a certain period. The main drawback of this method is that it does not take into account the seasonal variation of load.The forecast at time (t+1) is given by the average of the time series data up to the latest observations i.e. upto t.

Mathematically,$F_{t+1}=\frac{1}{t}\sum_{i=1}^{t} Yi$

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(ii) Moving Average: It is one of the easiest and most commonly used time series forecasting technique. The key fact that is assumed here is that, "future is affected only by the recent past". Here, using the past few months of load demand is used to estimate the coming month's demand.

We calculate the mean using only "k" latest observations as,

$$F_{t+1}=\sum_{i=t-k+1}^{t} Y_i$$

Here, F_{t+1} is called a Moving Average of order "k", MA (k). This method is not accurate as t can causes some serious errors. One of the main reason is that by taking average over a certain period, we tend to neglect the randomness of the data. The effect of the random properties such as seasonality, customer class, and atmospheric effect can cause serious errors in this case.

(ii) ARIMA (Auto Regressive Integrated Moving Average):

ARIMA is one of the most appreciated methods of time series. These methods assume that the data have an internal structure such as autocorrelation, trend, or seasonal variation. They are based on the assumption that the future demand can be predicted simply by analysing the past events. ARIMA was introduced in 1970 by George Box and Gwilyn Jenkins. The correlation coefficient r_k gives the relationship between the original time series and another series identical to the original but lagging in time by k periods. In this case the original series will be the forecast data and other one will be the actual data lagged by k periods.

The auto correlation coefficient rk is given by:

$$r_k=\frac{\sum_{t=k+1}^{n}(Yt-Ynt)(Yt-k-Y)}{\sum_{t=1}^{n}(Yt-\bar{Y})2}$$

A general ARIMA model is represented by ARIMA (p, d, q) where P is order of autoregressive part, d is degree of first differencing and q is order of removing average part. Here we have used ARIMA (0,1,0) model.

This is an ARIMA(0,1,0) or AR(1) model defined by $Yt=C+\phi_1 Y_{t-1}+e_t$

If $\phi=0$, it is simply a white noise series. If $\phi=1$, it is equivalent to the random walk model. Now we can estimate the values of C and ϕ_t to fit the observed data.

Now, $\phi=\frac{(Xi-Xi)*(Yi-Y\bar{i})}{(Xi-X\bar{i})2}$

Here, Xi= Actual demand with time lag of one period

$X\bar{i}$ = Average of Xi

Yi= Actual demand

$Y\bar{i}$ = Average of Y

In this method any observation contains two parts one is the seasonal part which can be correlated with its previous counterparts and a purely random part which does not have any fixed characteristic and it is uncorrelated from period to period. e.g. Yt=c + $et$where et is called **White Noise.**

III. DATA COLLECTION

The first and foremost step of forecasting is the collection of data. The load data has been collected for January to December 2016 for the state of Assam from State Load Dispatch Centre, Kahilipara. The forecast has been done for the months of July to December 2016. The data has been rearranged to make the forecast on a weekly basis. The Sundays has been separated from the week days as the load data for Sundays tend to follow a different pattern from that of weekdays. The forecasting techniques have been applied for both these set of data and the comparison have been made to see which method is best.

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IV. RESULT AND DISCUSSION

After completion of the task of forecasting the load using different methods, we present a comparative graph of the actual load vs. the forecast load calculated using all the three methods mentioned earlier, i.e. simple average, moving average, and ARIMA(0,1,0).The almost horizontal line represents the forecast made simple average method and it is giving maximum error as compared to the original demand which is represented with the black curve.So the forecast given by simple average method can be discarded in this case. The forecast made by moving average and ARIMA are shown by the green and the blue curves.

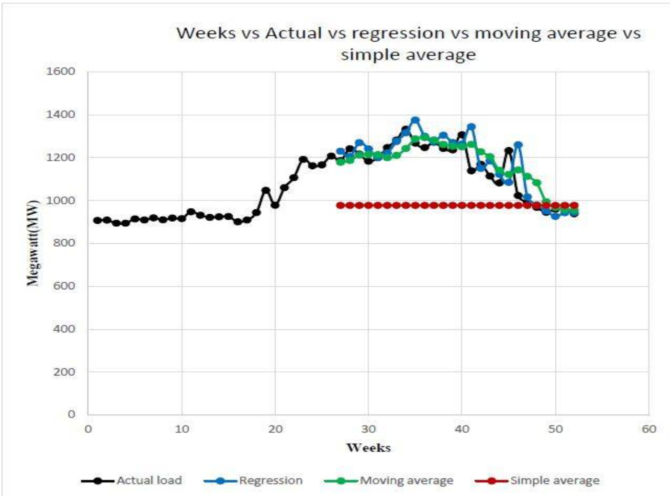

Fig.1 weekly forecast of actual load vs. forecast load (week days)

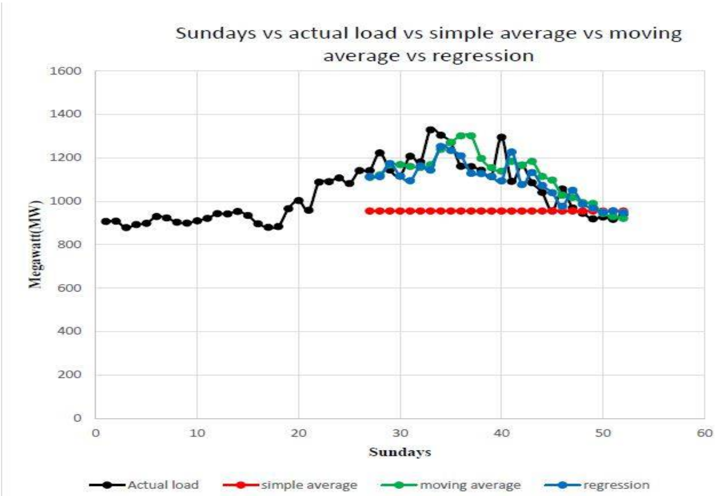

Fig.2 weekly forecast of actual load vs. forecast load (sundays)

From all the analysis of the graphs we have seen that comparison of actual load with the forecast load by using regression method (ARIMA) is mostly accurate than the other methods. Hence it will be suitable to use regression method for medium term load forecast.

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V.ERROR ANALYSIS USING FUZZY CONTROLLER

Its final forecasting efficiency has been evaluated by computing the **residue** or the **absolute error**between the actual and predicted values which can be defined by,

residue= $|Actual\ load - Predicted\ load| / Actual\ load$

We define a fuzzy controller with two inputs, actual demand and the predicted demand of the regression method and output is considered to be the **Fuzzy Error.**The membership functions have been defined accordingly and the rules are also formed by the author's own observation. The Fuzzifier converts the crisp value to fuzzy value and again in has been converted to crisp value using defuzzifier.

	LOW(L)	MEDIUM(M)	HIGH(H)	VERY HIGH(VH)
LOW(L)	L	L	M	H
MEDIUM(M)	L	L	L	H
HIGH(H)	M	L	L	M
VERY HIGH(VH)	H	M	M	L

Fig.3 Rule Table

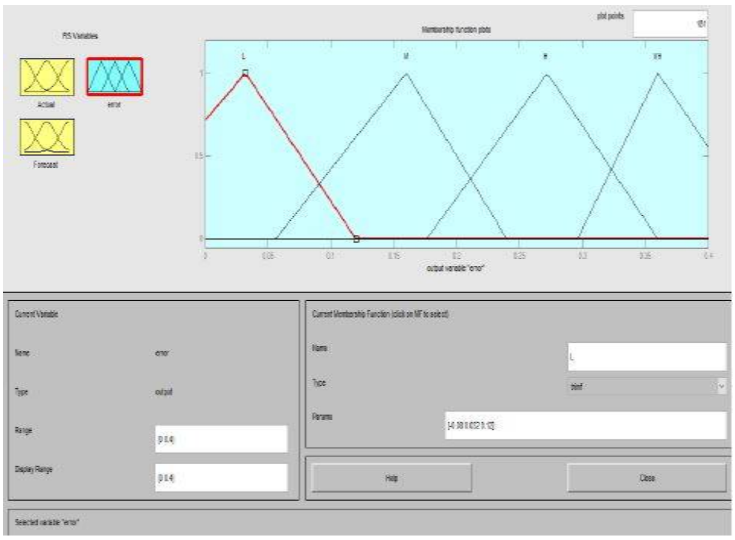

Fig.4 Membership Function for output (fuzzy error)

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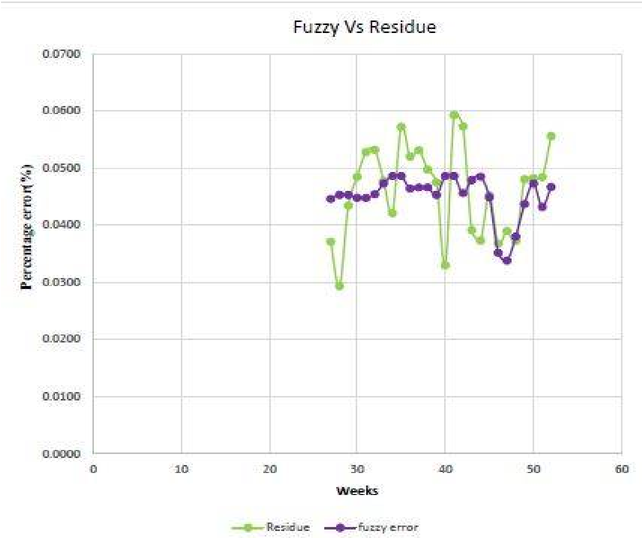

Fig.5 Comparative graph between fuzzy error and residue

The residue (errors) of regression method is compared with the errors calculated using fuzzy logic method. From the graph, it is observes that the errors obtained from the Regression Method has huge variations in some points(shown by the green curve. By applying Fuzzy Logic Method, the errors are again decreased to almost constant values. From week number (40-50), both errors falls and again starts rising. At around 47th week, the fuzzy error falls to the lowest.

The errors can be further minimized by tuning fuzzy logic controller by changing the membership functions and/or rule bases. This minimized error can be again used to upgrade the forecast value. The process will be continued until we get a perfect forecast**.**

VI. CONCLUSION

This work aims to forecast the load for the state of Assam from the period of July to December 2016. Here, the forecasting has been done by using simple average, moving average and regression based time series analysis (ARIMA). The final forecasting efficiency has been evaluated by calculating the residue or error between the actual and predicted values. The result suggests that regression Method is most accurate in forecasting the load as it almost replicates the actual result. The application of fuzzy controller also gives considerable reduction in error. There is scope of further improvement of error. Overall this forecasting method is a simple and efficient way and can be implemented on practical basis for doing an average prediction of load data for a certain period.

REFERENCES

[1] Mr.Dileshwar Prasad Patel,Anshu Tiwari,Dr.VivekDubey,"An Analysis of Short Term Load Forecasting by Using Time Series Analysis," International Journal of Research in Computer andCommunication Technology, Vol 2, Issue 2, Feb-2013
[2] RashmiRekhaBorgohain, BarnaliGoswami, "An Efficient Regression Based Demand Forecasting Model including temperature with Fuzzy Ideology for Assam," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 1, January 2015
[3] Nataraja.C, M.B.Gorawar, Shilpa.G.N., Shri Harsha.J., "International Journal of Engineering Science and Innovative Technology (IJESIT)," Volume 1, Issue 2, November 2012
[4] Mrs. J. P. Rothe, Dr. A. K. WadhwaniDr.S. Wadhwani, "Short Term Load Forecasting Using Multi Parameter Regression,"International Journal of Computer Science and Information Security, Vol. 6, No. 2, 2009
[5] A. Badri, Z. Ameli, A.MotieBirjandi, "Application of Artificial Neural Networks and Fuzzy logic Methods for Short Term Load Forecasting", ELSEVIER, Energy Procedia14(2012), pp 1883-1888
[6] EisaAlmeshaiei, Hassan Soltan, "A methodology for Electric Power Load Forecasting", Alexandria Engineering Journal(2011) 50, pp 137-144
[7] D.K. Chaturvedi, Sinha AnandPremdayal, Ashish Chandiok, "Medium Term Load Forecasting using soft computing Techniques", Int. J. Communications, Network and System Sciences, 2010, 3, pp273-279
[8] Dr.K.Uma Rao," Power system operation and control" , Wiley Publishers
[9] V.Venkatesh, Shilpa G N, Nataraja.C, "Study & Development of Short Term Load Forecasting Models Using Stochastic Time Series Analysis,"International Journal of Engineering Research and Development**,** Volume 9, Issue 11 (February 2014), PP. 31-36
[10] LOAD GENERATION BALANCE REPORT 2016-17, Central Electricity Authority, Ministry of Power, Government of India