International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

ARIMA Based Short Term Load Forecasting for Punjab Region

Sarabjit Singh[1], Rupinderjit Singh[2]

[1]Electrical Department, RIMT Polytechnic College, Mandi Gobindgarh, India

[2]Professor, Department of Electrical Engineering, Guru Nanak Dev Engineering College, Ludhiana, India

Abstract: ***This paper deals with the STLF (Short Term Load Forecasting) using ARIMA (Auto Regression Integrated Moving Average) method to developed forecast of Northern INDIA, where historic results are used to determine the future load for next day or for next week. Our main focus is to minimize the (MAPE) Mean Absolute Percentage Error in the analysis and results. We purpose a three step method to load forecasting, consisting of pre-processing, forecasting and result analysis in post processing. This model is based on Time Series analysis methodology with the combination of explana- tory variables by using the daily electrical load forecast. This method makes accuracy higher than other methods.***

Keywords: Short Term Load Forecasting, ARIMA (Auto Regression Integrated Moving Average), (MAPE) Mean Absolute Percentage Error.

1. Introduction

Short –Term load forecasting contributes a vital role in the energy management system. All the distribution and transmission companies require accurate and reliable method for the operation scheduling [1], unit commitment, fuel purchases and system planning [2]. One hour or one day ahead forecast is a important input to regular supply and demand after the bilateral trading between generator and supplier [3], [4].

Various statistical methods have been purposed for short term load forecasting [5], [6], Whereby the lead time under consideration vary from a minute up to a day ahead.

1.1 Autoregressive-Moving Average Model

The autoregressive-moving average or ARMA (p,q) model is that the value taken by a time series at a given time t, denoted y , depends on two additive terms: (i) the past of the time series (an autoregressive component of order p) and (ii) the past of the disturbances of the data generation process (a moving average component of order q). Hence, the general form of an ARMA model is

$$y_t = x_t \beta_t + u_t$$

$$u_t - \phi_1 u_{t-1} - \cdots - \phi_p u_{t-p} = e_t$$

$$e_t \sim N(0, \sigma^2).$$

1.2 Autoregressive-integrated-moving average model

The autoregressive-integrated-moving average, or ARIMA (p,d,q) model differs from the ARMA (p,q) model in one significant way: it contains a d parameter. This parameter states the level of non-seasonal differencing that is required to render a non-stationary time series stationary (when differencing is appropriate). Once stationarity is achieved, the series can be represented using an ARMA (p,q) model. Note that if the series is already stationary and does not need to be differenced, then it can directly be modelled through an ARMA (p,q). The general form of the ARIMA (p,d,q) model reads

$$\left(1 - \sum_{i=1}^{p} \phi_i B^i\right) (1 - B)^d X_t = \left(1 + \sum_{i=1}^{q} \theta_i B^i\right) \varepsilon_t \, .$$

1.3 Objectives of the Work

The task of the paper is to design a model which could formulate the load consumption for a typical day. As it may be seen, many methods have been developed for load forecasting. From the experimental results the conclusion can be drawn that different methods might outperform others in different situations, i.e. one method might gain the lowest prediction error for one time point, and another might for another time point. In order to accomplish this aim, the following objectives are to be achieved:-

a. The process of load forecasting requires a time series of historical data, thus it is required to gather the historical load data.
b. Climatic conditions may affect the load greatly, especially in areas where sudden weather changes are always anticipated. Thus this work do not takes into account the weather effect on the load.
c. To acquire and set up a convenient local data management system (database) for storing all collected data.
d. The possible existence of bad data in the load curves as well as in the weather data cannot unfortunately be discarded. Therefore one of the objectives is to develop a strategy aimed at detecting and eliminating the bad data.
e. The power system operators with their long time working experience might have some good intuition in manual load forecasting. Therefore it is extremely important to combine their experience in convenient manner.
f. The other important objective is find convenient model training approach that yields the best results.

1.4 Methodology/ Planning of work

The scope of this work is purely based on the Auto Regression Integrated Moving Average (ARIMA) method.

Only short-term load forecasting is modelled and analyzed in this research work. Although seasonal load variations (winter and summer) are considered, major sudden changes of load are not easily detected by the models. Forecasting the load for holidays or special days does not form part of this work. The training data set used in this work will limited to one week of historical load pattern.

2. Problem

The objective of the paper is to develop a program in MATLAB software to minimize the Mean Absolute Percentage Error (MAPE) and to improve the accuracy in the results of the Short Term Load Forecasting by using ARIMA model i.e. to minimize the error and simultaneously improving the accuracy without violating the constraints
The standard FORECASTING problem can be written in the following form,
Minimize MAPE (the objective function)

$$\text{MAPE} = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|$$

where A_t is the actual value and F_t is the forecast value.

3. Present Work

In this system, a program is designed in MATLAB software to minimize the error in the forecasting. First of all the historical data is used for pre-processing of the model. ARIMA models are regression models that use lagged values of the dependent variable and/or random disturbance term as explanatory variables. Auto regression models should be treated differently from ordinary regression models since the explanatory variables in the auto regression models have a built-in dependence relationship.

Auto Regression model

Consider regression models of the form

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p + \varepsilon$$

Then the previous equation becomes

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \varepsilon_t$$

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \varepsilon_t$$

The explanatory variables in these equations are time-lagged values of the variable y and is called auto regression model.

Moving average model

A time series model which uses past errors as explanatory variable:

$$y_t = \beta_0 + \beta_1 e_{t-1} + \beta_2 e_{t-2} + \cdots \beta_p e_{t-q} + \varepsilon_t$$

is called moving average(MA) model.

Autoregressive (AR) models can be coupled with moving average (MA) models to form a general and useful class of time series models called Autoregressive Moving Average (ARMA) models. These can be used when the data are stationary. This class of models can be extended to non-stationary series by allowing the differencing of the data series. These are called Autoregressive Integrated Moving Average (ARIMA) models. ARIMA models rely heavily on the autocorrelation pattern in the data. This method applies to both types of data.

4. Various Steps for Forecasting

1) Stationarity Checking and Differencing
2) Model Identification
3) Parameter Estimation
4) Diagnostic Checking
5) Forecasting

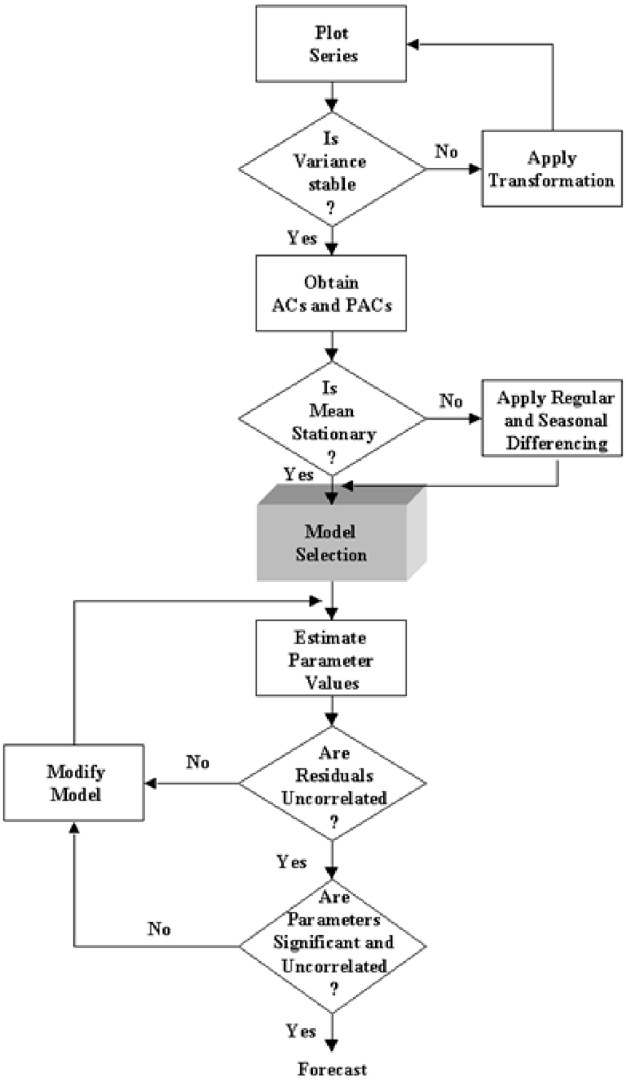

Chart-1 Flow Chart for Steps of Forecasting

5. Result and Discussion

The actual load, forecasted load by SLDC and forecasted load using ARIMA method, all are compared for one week which shows the suitable results. Take 01-04-2015 as a reference day and starts the forecasting for upcoming week. Then compare that forecasted data with the original data used and plot the graphs for each day

5.1 Results for 02-April-2015 (Thursday)

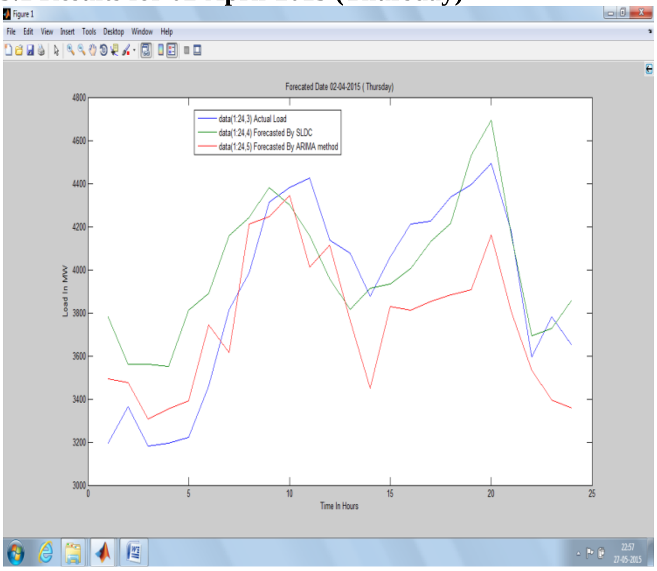

Figure 5.1: Load graph for 02-04-2015

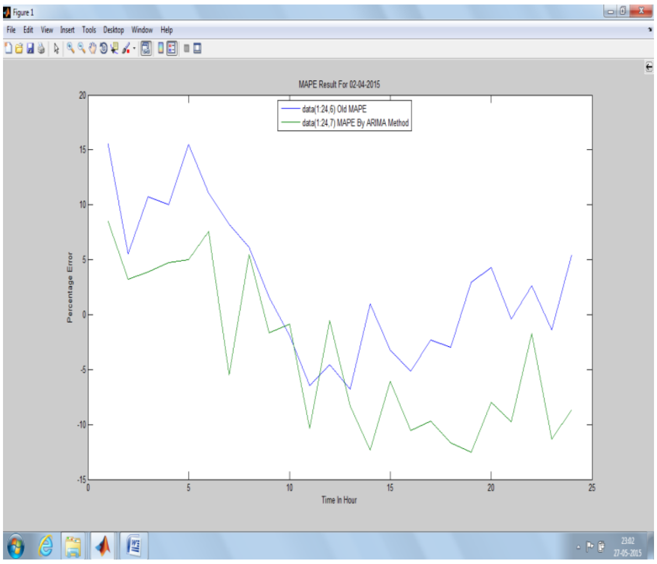

Figure 5.2: MAPE graph for 02-04-2015

5.2 Results for 03-04-2015(Friday)

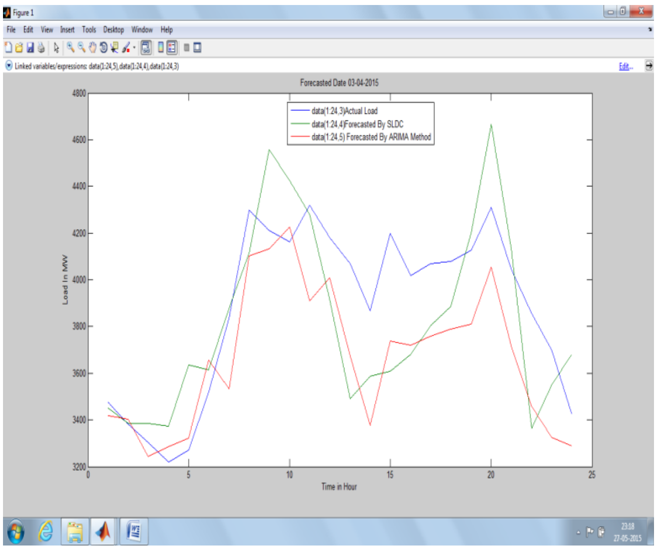

Figure 5.3: Load graph for 03-04-2015

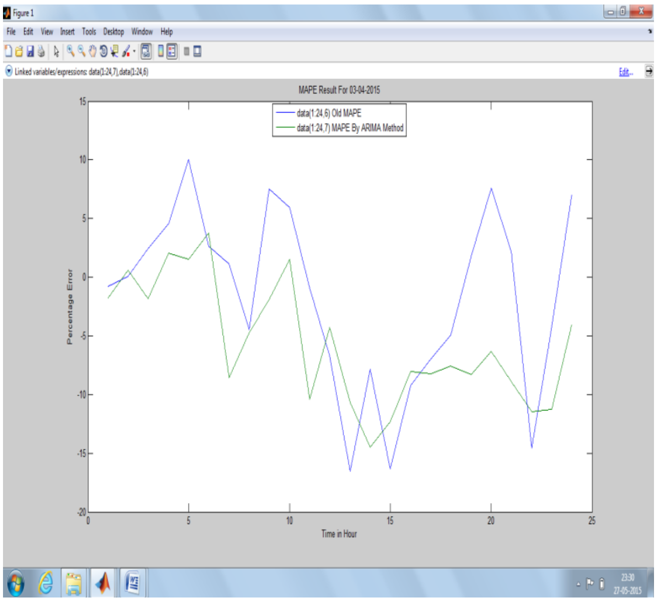

Figure 5.4: MAPE graph for 03-04-2015

6. Conclusion

An ARIMA Based Short term load forecasting has been presented and applied to the practical power system. From the results it can clearly seen that this model approach is more effective which relates the prediction variable to the other explanatory variable. This method is more reliable and improved method than the single forecasting method because it is less sensitive to poorer prediction methods. Another advantage is that not even a single parameter is calculated manually and it adapted using realized data in the identification period. The proposed method is only sensitive to weather data like temperate and wind speed. This is the best suited method because very small errors are acceptable in a practical uses. But this method does not respond to the sudden change in load. From the results, we also conclude that the error produced by the ARIMA method is less as compared to the method used by SLDC Patiala. Due to the less error produced, the cost will automatically reduce for the system.

7. Future Scope

This method can become very useful for the short term load forecasting. Despite the non availability of load flow analysis data and techniques required fitting and accuracy can achieve. The data requirements increase very sharply with the increase of power system and level of accuracy. While the deterioration of the forecast accuracy is found to be mild over short term and it becomes more severe for other terms when using the same SARIMA model. SARIMA method is found to be more efficient, accurate and require computational time, therefore require some motivation to use this data intensive model effectively. In future ARIMA method can be used with seasonal variables like pressure, humidity etc. At that time this method becomes the SARIMA (Seasonal Auto Regressive Integrated Moving Average) method.

References

[1] JP. Rothe, A.K. Wadhwani, S. Wadhwani, “Hybrid and integrated approach to short term load forecasting”, IEEE Transactions on Power Systems, vol. 2, issue12, pp. 7127-7132, 2010.

[2] S.A. Soliman & Ahmed Mohammad Ai, “Electrical Load Forecasting”, Butterworth-Heinemann, 2010.

[3] Qingqing Mu, Yonggang Wu, Xiaoqiang Pan, Liangyi Huang & Xian Li, “ Short Term Load Forecasting Using Improved Similar Day”, Power and Energy Engineering Conference (APPEEC0,pp. 1-4, 2010.

[4] S. K. Aggarwal, L. M. Saini, and A. Kumar, “Electricity price forecasting in deregulated markets: A review and evaluation,” *International Journal of Electrical Power and Energy Systems*, vol. 31, no. 1, pp. 13– 22, 2009.

[5] P. Paretkar, “Short-Term Forecasting of Power Flows over Major Pacific Northwestern Interties : Using Box and Jenkins ARIMA Methodology,” M.S. dissertation, Dept. Electrical and Computer Engineering, Virginia Tech, Blacksburg, 2008.

[6] C. A. Maia and M. M Goncalves, “Application of switched adaptive system to load forecasting,” Electric Power Systems Research, vol.78, 2008, pp.721-727.

[7] J. Taylor and P. McSharry, “Short-term load forecasting methods: An evaluation based on European data,” *IEEE Trans. Power Syst.*, vol. 22, no. 4, pp. 2213–2219, Nov. 2007

[8] R. Weron, *Modeling and Forecasting Electric Loads and Prices : A Statistical Approach*, 2006.

[9] Nahilkandil, Rene Wamkeue, MaaroufSaad, and Semaan Georges, “An efficient approach for short term load forecasting using neural network”, International journal of Electrical Power & Energy Systems, vol.28, Issue 8, pp.525-530, October 2006.

[10] Fafal Weron, “Modeling and forecasting electricity loads: a statical approach”, John Wiley & sons ltd. 2006.

[11] T, Rashid and T. Kechadi, “A practical approach for electricity load forecasting”, Proceedings of world academt of science, engineering and technology, vol5, pp. 201-205,2005.