

Short Term Load Forecasting Using ARIMA Technique

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Abstract—This paper discusses a new algorithm of a univariate method, which is vitally important to develop a short-term load forecasting module for planning and operation of distribution system. It has many applications including purchasing of energy, generation and infrastructure development etc. We have discussed different time series forecasting approaches in this paper. But ARIMA has proved itself as the most appropriate method in forecasting of the load profile for West Bengal using the historical data of the year of 2017. Auto Regressive Integrated Moving Average model gives more accuracy level of load forecast than any other techniques. Mean Absolute Percentage Error (MAPE) has been calculated for the mentioned forecasted model.

Keywords-Load forecasting, STLF, Univariate method, ARIMA, MAE.

I. INTRODUCTION

To operate efficiently, a system must adjust the load curve to the available generation capacity, as fast as possible without bringing down the system. Load forecasting helps an electric utility to make important decisions. It can be divided into three categories: Short Term Forecasts, which are usually from one hour to one week, find its application in generation and transmission planning. Medium Forecasts, which are usually from a week to a year, are solely applied in maintenance scheduling, fuel supply planning. Long Term Forecasts, which are longer than a year, are used in Unit Commitment, Economic dispatch, Cost effective scheduling of resources and security analysis studies.

A variety of methods have been proposed, which includes so called day approach, various regression models, time series, neural networks, statistical learning algorithm, fuzzy logic and expert systems have been developed for short term forecasting. Among these, the time series approaches have been widely used. The idea of time series approach is based on that the power consumption of load pattern can be treated as time series signal with hourly, daily, weekly, and seasonal periodicities.

The purpose of this research paper is to construct a MATLAB implementation for building, identifying, fitting and checking models for time series, which is a sequence of successive and independent data points.

II. ARIMA

The Univariate time series methods are considered to be sufficient for the short times involved because the weather variable tends to change in a smooth fashion. ARIMA is a univariate method, which have been applied to a wide variety of time series forecasting applications. In this section, procedure to built ARIMA model for load forecasting has been described. The load data, that we have considered as the historical data for load forecasting is a non stationary time series data. Therefore, the time series data is needed to be adjusted to a stationary time series data by difference technique. This step may be repeated as per requirement. By using difference operator ∇ , the first order difference can be expressed as in Eq. (1),

$$\nabla Y_t = Y_t - Y_{t-1} = (1-B)Y_t \quad (1)$$

Where, Y_t : The t th time series load data
 Y_{t-1} : the $(t-1)$ th time series of load data
 B : backward shift operator
 ∇ : backward difference operator

For load data with periodicity, periodical difference operator ∇_s is incorporated in Eq. (2)

$$\nabla_s Y_t = Y_t - Y_{t-s} \quad (2)$$

The continuous and seasonal difference may be used together. This can be accomplished by Eq. (3)

$$V_s^d V^D Y_t = (1-B^s)^D (1-B)^d Y_t \quad (3)$$

where,

s : time span

D : seasonal difference order

d : continuous difference order

After completion of stabilization, ARIMA with order (p,d,q) is obtained.

$$\Phi_p(B) \cdot V^d Y_t = \theta_q(B) \cdot a_t \quad (4)$$

Where,

$\Phi_p(B)$: auto regressive operator

V^d : d th order difference

$\theta_q(B)$: moving average operator

p : auto regressive order

q : moving average order

a_t : a series of random variables in normal distribution

The procedure starts with observing the time series data and selecting proper d value to obtain proper stationary time series. The next step of model identification is to select proper p and q value by inspecting Auto correlation function (ACF) and Partial auto correlation function (PACF). The ACF index provides the information of moving average order in ARIMA model and the PACF helps to determine the p value. A complete ARIMA model can be expressed as Eq. (5).

$$\Phi_p(B^s) \Phi_p(B) V_s^D V^d Y_t = \Theta_Q(B^s) \theta_q(B) a_t \quad (5)$$

The value of p, d, q and s are determined by model identification. Then residual check and fitting check are applied. Finally, the model is applied to perform the load forecasting process.

$\Phi_p(B^s)$: seasonal auto regressive operator

$\Theta_Q(B^s)$: seasonal moving average operator

V_s^D : seasonal dth order difference

P : seasonal auto regressive order

Q : seasonal moving average order

s : time span

D : seasonal difference order.

III. RESULT AND DISCUSSION

In this paper we have forecasted the load demand of West Bengal for 31st July, 2017, Monday. To have as much as accurate forecast, here the load demand data of previous

Monday i.e. 3rd, 10th, 17th and 24th July, 2017 has been used as historical data.

We have also calculated MAE (Mean Absolute Error) using the formula :

$$MAE = \sqrt{\left(\frac{\text{Actual Value} - \text{Forecasted Value}}{\text{Actual Value}}\right)^2}$$

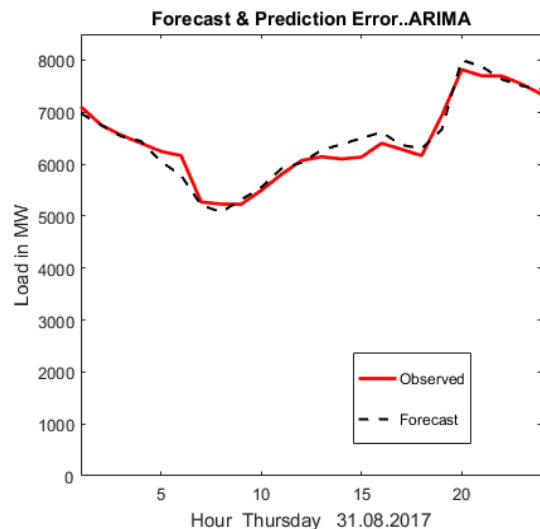


Fig. 1. Load Profile curve for 31.08.2017 using ARIMA with MAE = 2.1778%

IV. CONCLUSION

In this paper, an approach for Short Term Load forecasting as well as Real Time Load Forecasting has been proposed, which incorporates the time series modelling. To implement this, we have studied the hourly load demand and daily Peak load demand of West Bengal. It has been shown that the proposed method can provide more accurate result than any other conventional technique for weekly or monthly load forecasting and instantaneous load predictions for next several minutes. The best feature of the technique is that it requires few data and prediction efficiency is good enough. This technique is very useful for new sites, which have very few data to start with, helping to improve the forecast over time. Therefore, this more accurate prediction lead to more accurate decision making for demand side management.

Research work is under way in order to: 1. Incorporate more weather data, such as temperature, humidity etc. 2. Determine a separate model for Festivals and West Bengal State Govt. Holidays 3. Forecast the time of daily peak load 4. Tariff based load distribution 5. Optimum use of conventional energy source.

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