Annexure B

A comparative study of ARIMA and ANN model based solar power generation forecasting

B.1 INTRODUCTION

In this appendix the comparative solar power genenration forecasting using ARIMA and ANN model is explored. In this study, One-year solar power generation data from C- Si 58kW rooftop solar power plant of IIT Jodhpur is considered for comparative analysis of ARIMA (conventional time series model) and ANN based solar power generation forecasting. Description of the plant is given in section 3.2.1. Figure 1 show the one-year solar power generation profile of small-scale solar power plant. In this study min-max normalization method (described in section 3.2) is used for data normalization so we consider a small specified range in between 0.1 as min. and 0.9 as max where the actual minimum and maximum solar power generation is 42.49 and 340.41 kWh respectively.

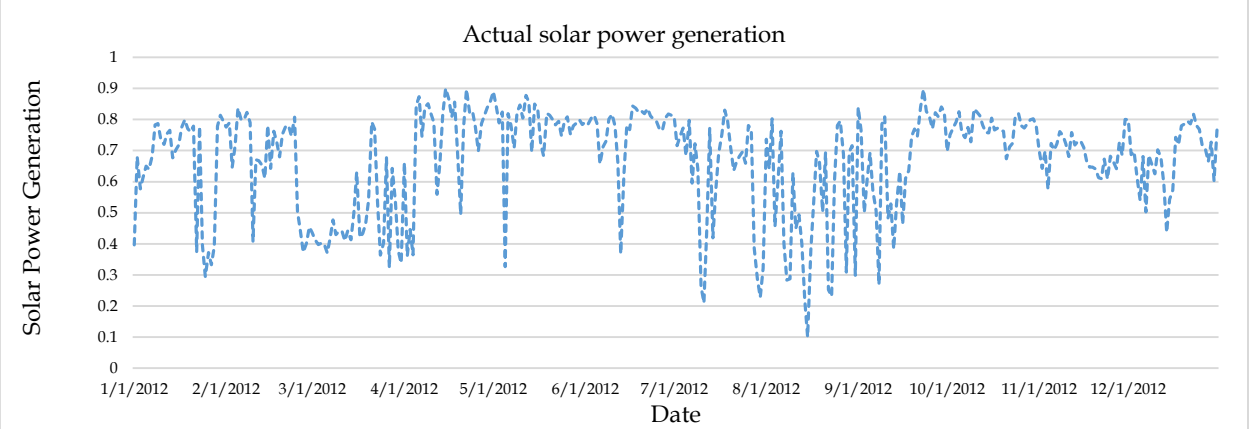

Figure B.2: One-year solar power generation data set

B.2 RESULTS

The graphical representation of the actual daily solar power generation and the forecasted daily solar power generation is shown in Figure B.2. Figure B.2.1 shows for one month (210- 245 data points: Month of August) comparative result of ARIMA and ANN forecasting.

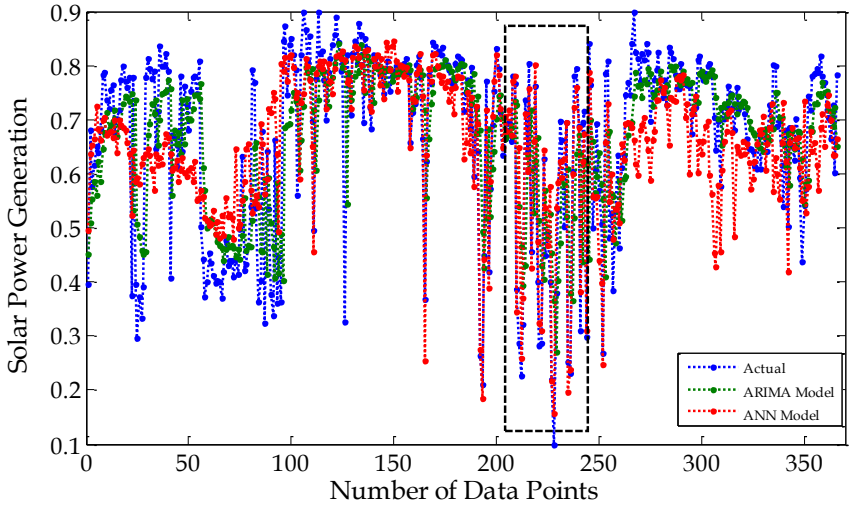

Figure B.2 : Comparison of solar power forecasting output of ARIMA and ANN models

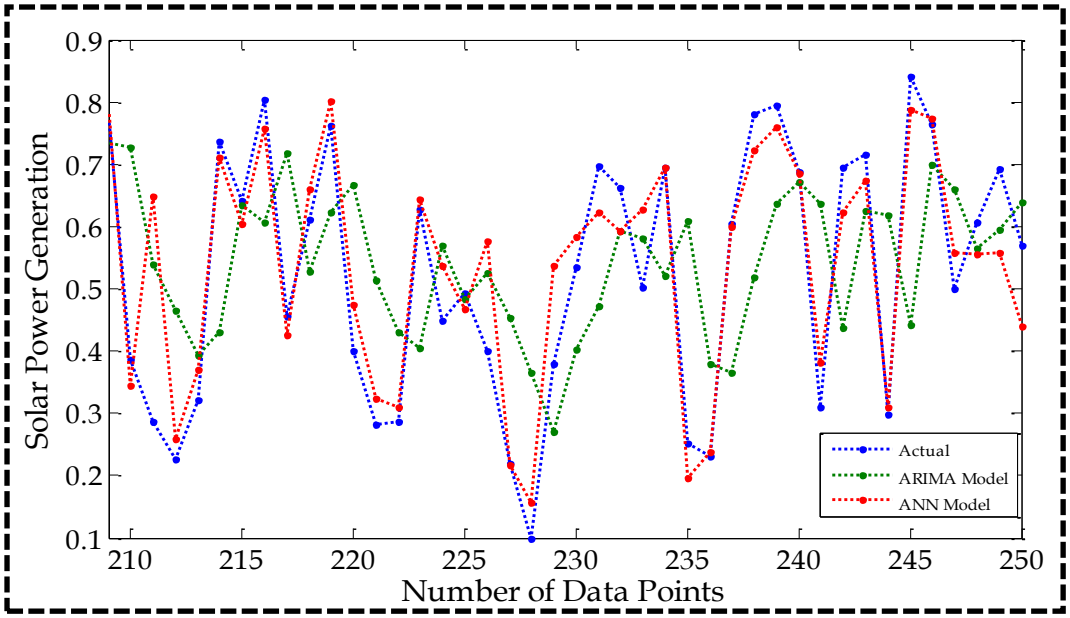

Figure B2.1: Comparison of solar power forecasting output of ARIMA and ANN models for one month

The obtained results from each of the models were organized and assessed in terms of the magnitude of the error metric between the forecasted output and the actual solar power generation. This was achieved by mean squared error (MSE) and measuring root of the average of the squares of errors (RMSE) which is shown in Table B.1. According to this table resultant errors are less in the case of ANN model as compared to ARIMA model. Figure B.2.2 also shows that the error deviation in ANN is less compared to ARIMA.

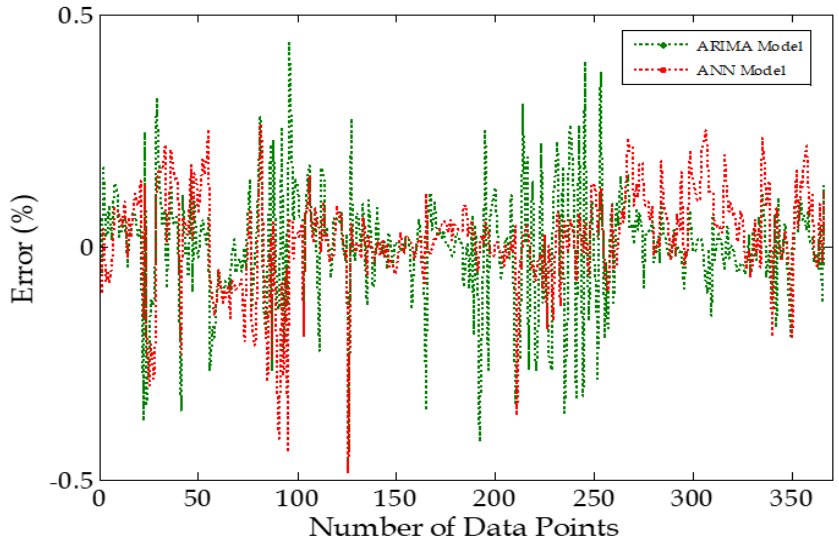

Figure B.2.2: Comparative error analysis of ARIMA and ANN Model

Table B.3: Comparative analysis of ARIMA and ANN model for solar power generation forecasting

Error Metric	ARIMA	ANN
MSE	0.0158	0.0122
RMSE	0.1255	0.1105

The findings revealed that the ANN model outperforms the ARIMA model so developed. It is observed that ANN approach demonstrated superior performance over the ARIMA model. It may be noted that de-trending of the data is not performed as suggested by John Boland et al (2016). As suggested by the external examiner, it is possible that ARIMA based forecasting can be as good as ANN. This topic is left for further work.

B.3. Conclusions

We find that ANN outperforms the ARIMA models for rooftop solar PV power plant data if de trending of the data is not carried out. Solar radiation is often a trend stationary data and if trend can be removed from the dataset then ARIMA model may be good enough but automatic trend removal may not be easy and the data pre-processing task can be cumbersome. In such cases, then ANN model is preferred choice. The unique characteristics of ANNs — adaptability, non-linearity, and arbitrary function mapping ability, thus, make them useful for forecasting tasks.

List of Publications

V. Singh, K. Vaibhav and D. Chaturvedi, ***'Solar power forecasting using soft computing approach'***, IEEE 3rd Nirma University International Conference on Engineering (Nuicone), Gujrat, India, pp. 1-5, 2012. DOI**:** 10.1109/NUICONE.2012.6493268

V. Singh, V. Vijay, B. Ravindra and R. Mandi, ***'Combined effect of deterministic and stochastic variables on comparative performance analysis of 101 kW A-Si PV and C-Si PV based rooftop grid tied solar Photovoltaic systems in Jodhpur'***, *Journal of CPRI*, Vol 9, iss. 02, pp. 279-290, 2013.

V. Singh, V. Vijay, S. H. Gaurishankar and N. Rajkumar, '***Analysis of solar power variability due to seasonal variation and its forecasting for Jodhpur region using Artificial Neural Network'***, *Journal of CPRI*, Vol 9, iss. 03, pp. 265-275, 2013.

V. Singh, V. Vijay and M. Bhatt, ***'Generalized Neural Network Methodology For Short-Term Solar Power Forecasting'***, *13th IEEE Envieronment and electrical engineering International Conference*, Poland, , pp. 210-215, 2014. DOI**:** 10.1109/EEEIC-2.2013.6737883

V. Singh, B. Ravindra, V. Vijay and M. Bhatt ***"A comparative performance analysis of C-Si and A-Si PV based rooftop grid tied solar photovoltaic systems in Jodhpur"***, *3rd IEEE Renewable Energy Research and Application (ICRERA), 2014 International Conference on*, Milwaukee, pp. 250-255, 2014. DOI: 10.1109/ICRERA.2014.7016565

V. Singh, B. Ravindra, V. Vijay, D. Chaturvedi and S. Jothi Basu**, *'Ground based measurement for solar power variability forecasting using Generalized Neural Network'***, Springer India 2015, V. Vijay et al. (eds.), System Thinking Approach for Social problems, Lecture Notes in Electrical Engineering, Vol. 327 India, 2015, pp. 40-47. DOI: 10.1007/978-81-322-2141-8_5

V. Singh, B. Ravindra, V. Vijay and M. S. Bhatt**, *'Forecasting of 5MW Solar Photovoltaic Power Plant Generation Using Generalized Neural Network'***, IEEE *39th National System Conference (NSC)*, Noida, India, Dec 2015. DOI: 10.1109/NATSYS.2015.7489107