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Large Scale Predictive Analytics based Real-Time Energy Management and Enhance Power Quality in Smart Grid

D.Chandra Sekhar
Ph.D Research Scholar,Department of EEE
JNTUA
Ananthapuramu , India
daram.sekhar@gmail.com

P.V.V.Rama Rao
Professor in EEE
Maturi Venkata Subbarao Engineering College, O.U
Hyderabad, India
pvvmadhuram@gmail.com

R.Kiranmayi
Professor in EEE
JNTUA
Ananthapuramu,India
kiranmayi0109@gmail.com

***Abstract*—Energy use has increased dramatically in recent years. As the world's population grows, so does the need for electricity. The LSTM Algorithm is used to anticipate energy management and manage real-time energy in this paper and ANF control algorithm based smart grid to solve power quality issues is investigated in this paper. To maximize both power generations, back-to-back voltage source converters (VSC) are operated with an intelligent ANN controller. Optimal power converters are adopted this proposed methodology and improved overall performance of the system in a acceptable limit. The simulation results are obtained for different mode of smart grid and non-linear fault condition and proven proposed control algorithm works well. The information is presented as data sets. It has been discovered that a significant quantity of energy will be required in the future to train data, depending on the amount of energy consumed in the future. It has the ability to track training progress in real time. In order to forecast future events, this article used 440 daily energy consumption estimates and 250 iterations. MATLAB/Simulink is used to validate the results.**

***Index Terms*—Time-Series Analysis,Curve-Fitting Loop, RMSE, LSTM,ANN,Power Qulaity,MATLAB/SIMULINK**

I. Introduction

These days, energy usage is at an all-time high in factories, homes, schools, malls, and commercial reasons, among other places. As demand rises, so does energy output. Control in houses and buildings is normally performed with motion sensors and cameras, but integrating motion sensors and energy consumption[1] is a very different technique. The availability of mass data based on time or telemetry is one of the primary issues surrounding the idea of "Metadata." With the advent of low-cost capture and storage technologies, it is now possible to get extremely precise data for use in subsequent analyses[2], [3]. The term "very high-resolution detail" relates to time. Almost all devices can now capture time-flow data, which may then be interpreted to learn more about the underlying system or better forecast future occurrences[1]. In the realm of energy, there has been a lot of study on cost-cutting strategies for families and structures. The development of systems for the management of domestic energy, which is described as a system that allows the user to regulate, analyze, and optimize energy consumption at home[4], is one of the topics that has been highlighted. The self-adaptive strategy as an addition to the method based on the relative model[5] is determined using ANN, a non-linear datum. They were effective instruments to use, particularly when the underlying data report was unknown.

II. Time Series Analysis

Temporal series analysis is nothing, but a thorough evaluation of the values seen at various times in time leads to distinct issues[1]. Many traditional statistical approaches involving random sampling can benefit from the clear dependency established by sampling data on time limitations. "Time series analysis" is a term used to describe the psychoanalysis of this data[6]. Managing and managing actual energy supply is a resource issue and prediction that is influenced by a variety of factors, some of which can be monitored within the network and others that are only available outside the network, such as the climate, resident behaviour, and the economy.

III. ANN (Artificial Neural Network)

The related designs between the input data sets and the appropriate goal values may be recognized and learned by ANN. The ANN will be used to forecast the outcome of fresh self-sufficient input data after it has been trained. The neural controller is a typical 2-level neural network model created using a neural network.

IV. Time Series Forecasting

ANN viewpoint was proposed as a strategy alternative for time series prediction and has gained enormous popularity in recent years[6], [7]. ANN major objective is to create a model as well as to replicate the intelligence of the human brain in a computer. ANN aim to detect the regularity and patterns in the incoming data, learn from the experience, and then deliver generalized findings based on their past known recognition, similar to how a human brain works[8], [9]. The most commonly used anns in forecasting problems are multilayer perceptron (SPLM), which use a single hidden feed

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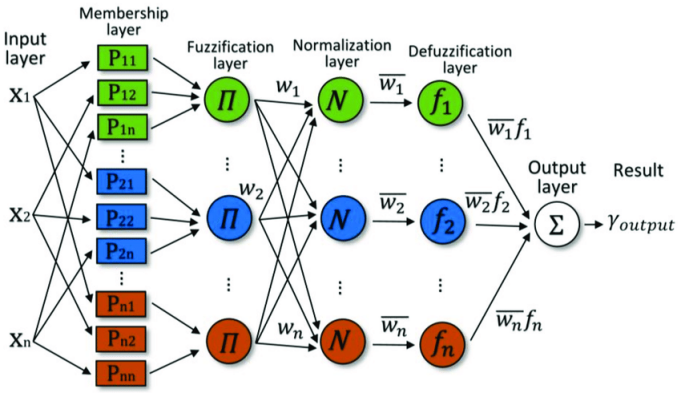

Fig. 1. Process Layer of ANN.

layer from the net (FFNS). The mode is distinct from a three-tier network, that is, input level, hidden layer, output level. These are connected by a cyclic connection. There may be more than one hidden level. Multi-layer nodes are also known as rendering elements.

V. DEEP LEARNIG

Deep learning, also known as deep-learning structure or hierarchical research, is a type of autonomous learning that is focused on learning data representations rather than specific techniques. Activities. Deep learning may be divided into two categories. They are: 1. Supervised learning 2. Unsupervised Learning

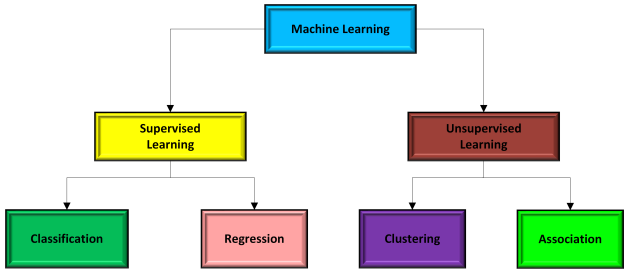

Fig. 2. Classification of Machine Learning.

Supervised Learning: In this method, each input pattern used to train the network is linked to an output pattern that is the desired or goal pattern[4]. Unsupervised Learning:

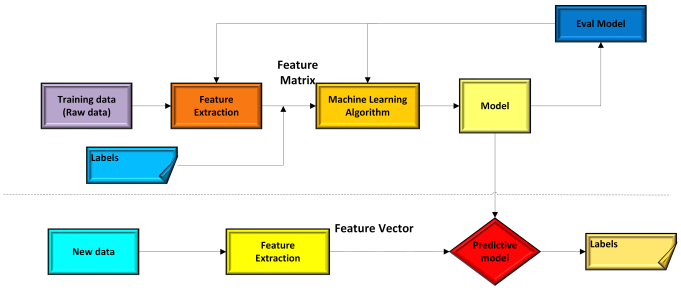

Fig. 3. Supervised Learning workflow.

The final output is not granted to the network in this form of unorganized learning[10]. Because each non-parsed input value is utilized to train the network and is coupled with a desired or target model in which the research is not supervised, this project was completed using monitored learning.

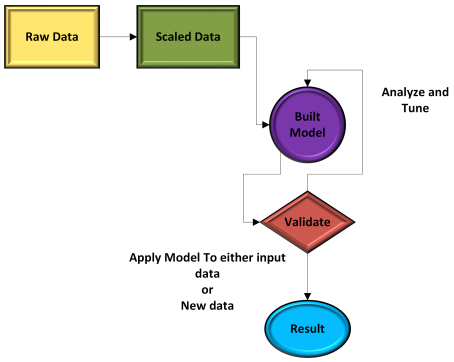

Fig. 4. Unsupervised Learning workflow.

VI. CURVE FITTING TOOL

The process of building a curve and adapting better to a succession of values, sometimes subject to limitations, is characterised as the curve adjustment tool[11]. To anticipate energy use, the Curve Adjustment tool is employed. However, it does not anticipate the next data[5]. This is the one disadvantage of the curve adjustment tool, thus we'd rather utilise a LSTM. method because of it. A long short-term memory algorithm is abbreviated as LSTM.

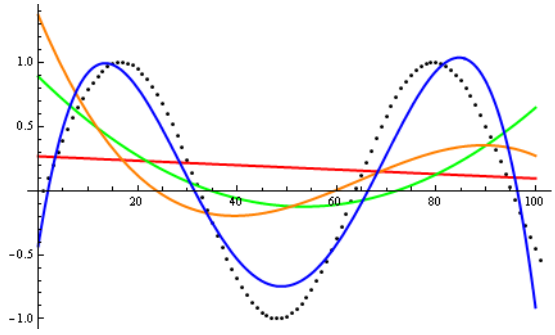

Fig. 5. Curve Fitting.

A. RMSE

The Root Mean Square Error[4] is defined as the difference between the estimated and actual data. Our goal is to lower the mistake rate. Our forecasts are more accurate than the real facts. However, there were some non-identical strategies to reduce the error term[12]. We must reduce either the square error or the absolute error value.

$$RMSE = \sqrt{\frac{\sum(predicted_i - Actual_i)^2}{N}} \quad (1)$$

B. LSTM NETWORK ANALYSIS

A long short-term network algorithm of memory is abbreviated as LSTM. The RNN has its own LSTM units and is commonly referred to as an LSTM network[6]. A typical LSTM unit consists of one or more cells.
(1) an inlet door
(2) an exit door
(3) a door to oblivion.

Three ports govern the flow of information in and out of the cell, which gathers data on arbitrary disruptions. A family building is constructed using a memory cell, an output gate, and an Oblivion doorway, among other designs of LSTM units. For a period of time, a LSTM cell takes a voice and the reserve[6]. Because the identity function's derivative is permanent, this is the same as applying the identity function $[f(x) = x]$ to the input. The gradient does not disappear when a LSTM network is trained with backward propagation.

VII. DATA LOADING METHOD

Power (in watts) holds a one time series, with time steps proportionate to months and values corresponding to number of cases. data = 1×500

To predict data from the first time steps of an array, we must train a series lapse an LSTM network, in which the responses are used to train sequences with data that is shifted by one time step. In the first 90% of the data stream, it rains, and in the latter 10%, it tests. List the replies as tutorial sequences with altered values using a single time pass to estimate the values of future time steps in a series[13]. The LSTM network is situated in each phase of the input sequences to anticipate the following phase data[14], [15]. As can be seen in Fig.8, the error is really high, thus we must anticipate the specifics in order to lower it. The network will function correctly if the misperception is reduced. In Fig. 9, the inaccuracy is decreased by anticipating the data, resulting in high-decisive predictions when renovating the state of the network with perceived values rather than expected values.

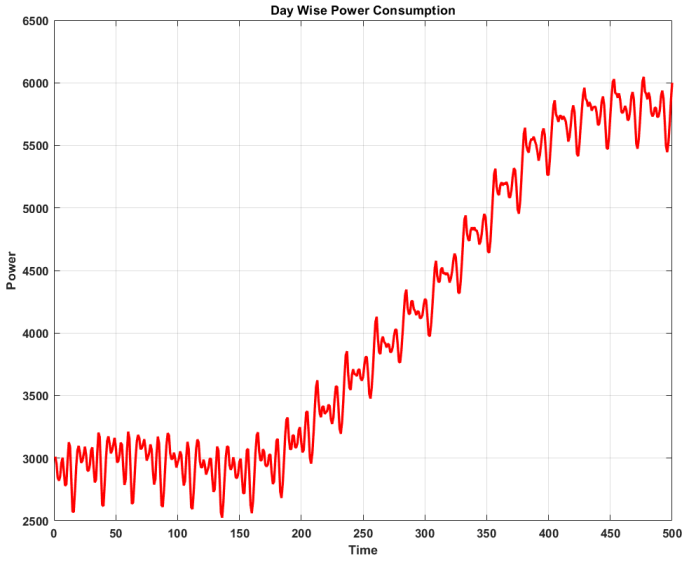

Fig. 6. Day wise power consumption.

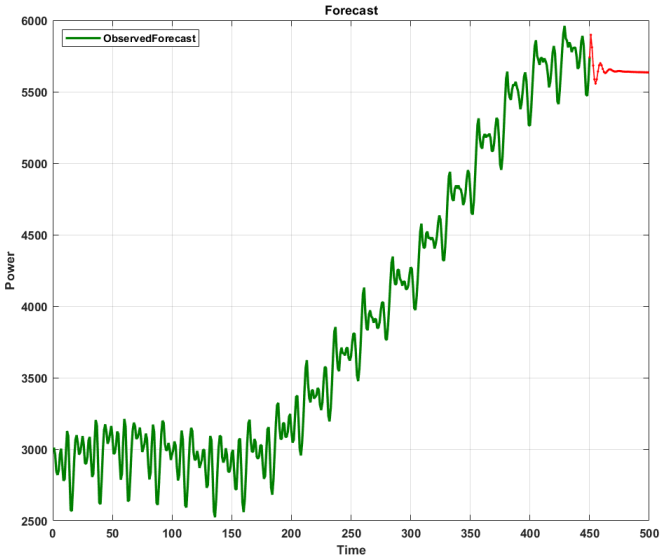

Fig. 7. Forecasting without updates.

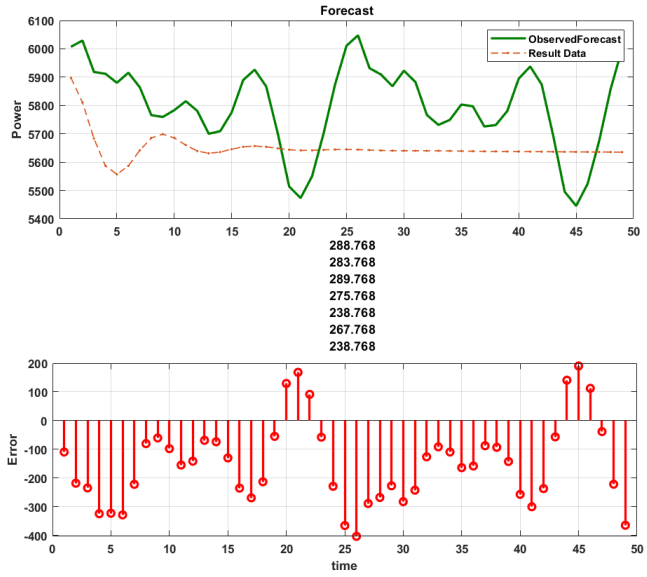

Fig. 8. Forcasting without updates (rmse = 66.3617).

VIII. ANN BASED VSI CONTROLLER DESIGN

The performace of the smart grid is shown in Fig.11 to Fig.14 those are voltage at DC link capacitor, wind power, solar power, grid current, Voltage across CPI, VSR modulation respectively. Effective power management done in smart grid with employing ANN operated VSC converters.

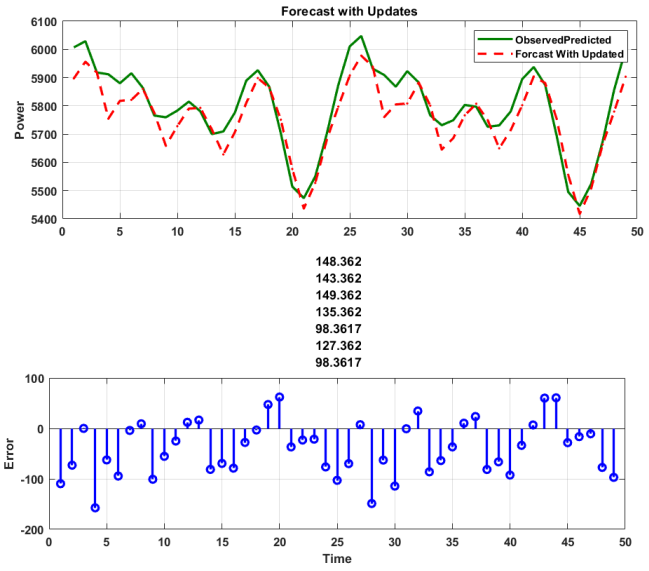

Fig. 9. Forcasting with updates.

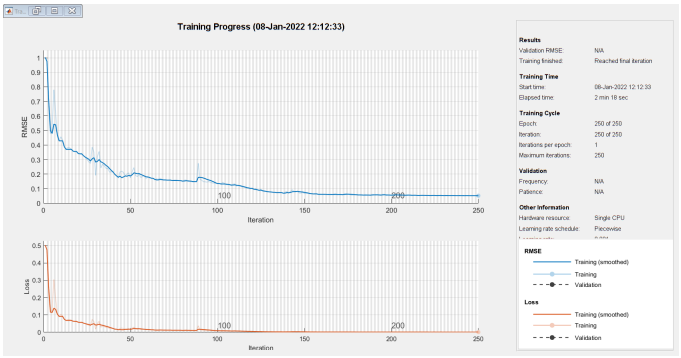

Fig. 10. Training progress of real time energy management per day (rmse = singlen206.7675).

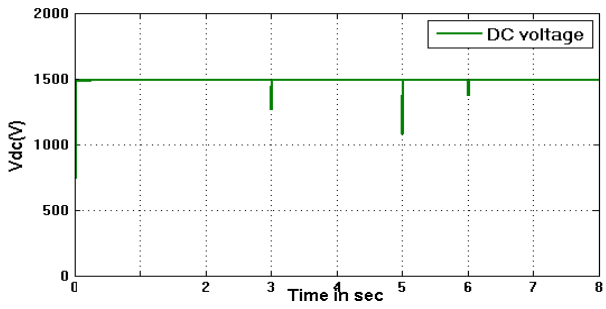

Fig. 11. DC link Voltage.

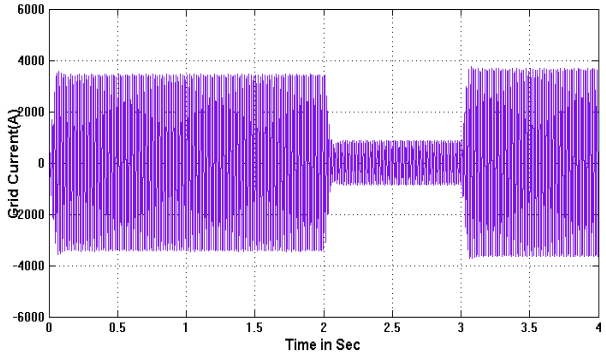

Fig. 12. Grid Current .

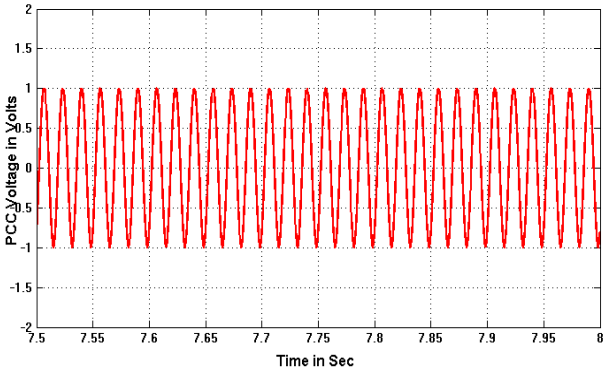

Fig. 13. Voltage at CPI.

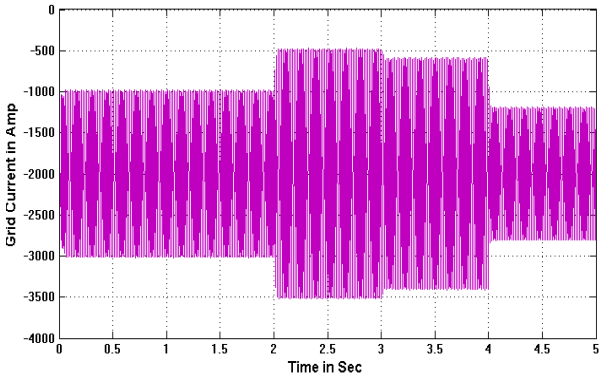

Fig. 14. VSR Modulation.

IX. Conclusion

Using the LSTM network technique, we forecast a big quantity of energy in this article. We looked at the information in the form of a data set. This project was completed using MATLAB. Finally, by training the data that we have based on previously utilized energy, we were able to determine how much energy will be required in the future. The LSTM network is well-suited to categorizing, analyzing, and forecasting time series data. We used one-day data, which consisted of around 484 values and 250 iterations. Data is presented in the form of data sets. Varying dwellings will consume different amounts of energy. We trained a sequence-to-sequence regression LSTM network to forecast the values of future time steps in a sequence, where the responses are the training sequences with values shifted by one time step. As a result, when updating network state with actual values rather than expected values, the predictions are more accurate. Finally, by employing the LSTM network, we may see a reduction in loss. In comparison to a traditional PI controller, simulations show that the current harmonic content is reduced by 19.61% to 12.72% and the voltage harmonics are reduced by 44.55% to 14.05% in ANN. Furthermore, as compared to traditional control-based systems such as PI controllers and individual loop control techniques, it has superior dynamic performance.

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