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Optimized Energy Forecasting Using Hybrid Long Short-Term Memory Technique

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Abstract

Energy needs are increased day to day, as the world is developing in all the sectors of energy. So, it is one of the vital factors for all the purposes of daily works and boundless demand for precise energy forecasting. It is to be provided for lower cost and also it should be stable, this will become the most challenging task for the energy service providers. Energy forecasting is typically available only for bigger regions. In this paper, we propose the hybrid Cat Swarm Optimization (CSO) with Long Short-Term Memory (LSTM) model for finding energy consumption to India by 2027. The proposed CSO-LSTM is designed by integrating with metaheuristic swarm-based optimization algorithm is applied on the dataset of Central electricity authority, Government of India. This approach is implemented in pycharm, colab software with the given time series data. Here, the optimal feature extractions are trained using LSTM model. Proposed method achieved best performance which can be understood from the metrics of Mean Square Error (MSE) reduced by 0.015 and Root Mean Square Error (RMSE). From the results that the implemented model CSO-LSTM is produced the best energy efficiency when compared with existing models.

Keywords: Energy Forecasting, Robustness, Scalability, CSO, LSTM

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1. INTRODUCTION

Energy needs are increasing day by day, as the world is developing in all the sectors energy is one of the vital factors for all the purposes of daily works and boundless demand for precise energy forecasting. The proposed CSO-LSTM is designed by integrating with meta heuristic swarm-based optimization. This algorithm is used to forecast the energy consumption in future with the growth dataset of Central electricity authority, Government of India. A hybrid strategy is effective for maximising the deep long-term memory approach, which results in a faster rate of convergence throughout the training phase and permits the development of small-scale decentralised systems. Time-series data can be handled well by deep learning methods like Long Short Term Memory (LSTM) and its variations.

2. RELATED WORKS

An in-depth analysis algorithm of the cat swarm optimization (CSO) which was motivated by the regular behaviour of cats. CSO is a strong and effective swarm-based metaheuristic optimization method that has gotten a lot of positive comments. The CSO algorithm is still a contender in the space [1]. The demand for energy and resources has grown more significantly as a result of the growing population and rising standard of living. The precise assessment of rising electricity energy demand is a requirement to planning tactics, boosting profits, avoiding electricity waste, and ensuring the energy demand management system runs steadily [2].

Created the cutting-edge, unique power demand forecasting system based on the LSTM Deep-Learning technique with relation to current power demand patterns. Residential facilities, which are impacted by the weather, had a higher forecasting error rate than other facilities when using power demand data as input [3]. In order to predict and forecast the variable energy demand in decentralised power systems in overall and houses in specific and proposed idea to do the implementation with the feature selection. Improved forecasting of electricity demand with more predictors that is a greater risk of over-fitting in prediction models [4].

The system is made up of the two processes of extracting the highest peaks and load forecasting. It provides long-term forecasting, and the model is trained using data from prior years and serves an output. Reduce the requirement for last-minute non-renewable energy generation [5]. In order to develop the power generator sector and get ready for routine operations, anticipating electricity demand is crucial. Due to the intricacy of the available demand patterns, predicting future electricity demand can be difficult [6].

The main goals of implementing renewable energy in India are to encourage trade and industry development, improve energy security, and grow then trance to energy. It has also been determined what challenges the renewable sector is currently facing.

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The recommendations based on the review's findings give entrepreneurs, investors, industries, departments, researchers, and scientists vital information. Renewable technology uptake is hampered by a lack of thorough regulations and regulatory frameworks [7]. The straightforward defence system to guard against pollution and resource depletion in the environment. Using a photovoltaic (PV) system, solar energy is a renewable resource that may be transformed into electricity [8].

In order to address the unfavourable convergence behaviour of the optimization methods that is used to static sized windows of previous gradients to measure the gradient apprises to increase the performance [9].

3. PROPOSED METHODOLOGY

The proposed system is used to predict the energy consumption in the next 5 years using CSO with LSTM. In order to improve accuracy, it uses the dataset that was gathered at Central Electricity Authority (CEA), India to identify the best attributes.

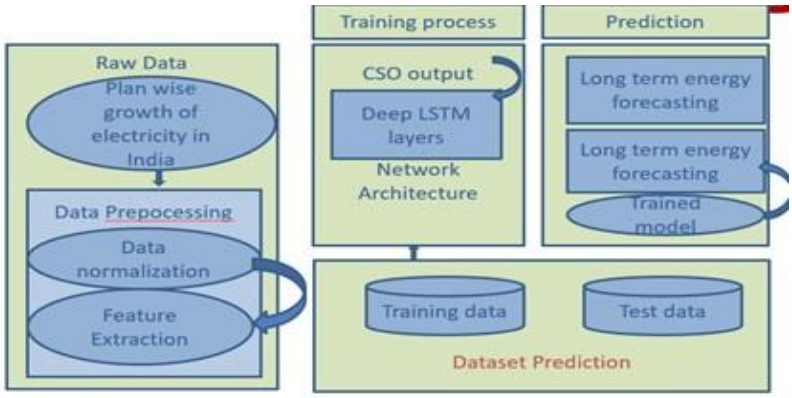

Figure 3.1.Architecture Diagram for Proposed Energy Forecasting System

Proposed schematic diagram for energy forecasting using CSO with LSTM shown in Figure 3.1. It is used in Pycharm, Jupiter, and Colab, and real-time data were used in the study. Deep LSTM model with CSO is used to train the ideal features. The findings of the proposed model are compared to those of the existing models in terms of set up capacity forecast, village electrification, hydro, coal, diesel, nuclear prediction, etc. The suggested model improves mean squared error (MSE) and root mean square error (RMSE) for LSTM by a percentage. Energy consumption is projected with a point of interval of 5 years' head using time series data sets from several utilities that have been educated using a hybrid model.

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3.1 Data Pre-processing: The real-world datasets gathered may contain errors because to inconsistency of data. In order to prepare the data for future analysis, it is essential of the numerous pre-processing methods for handling unclean data.

3.2 Data Cleaning and Data Transformation: Data transformation is used to scale the properties. Redundancy data are eliminated and then number of attributes is decreased using data reduction procedures. Data should be standardized using the Min-Max scaler to prevent bias throughout the training phase. The data transformation phase is applied to the input values of time series data.

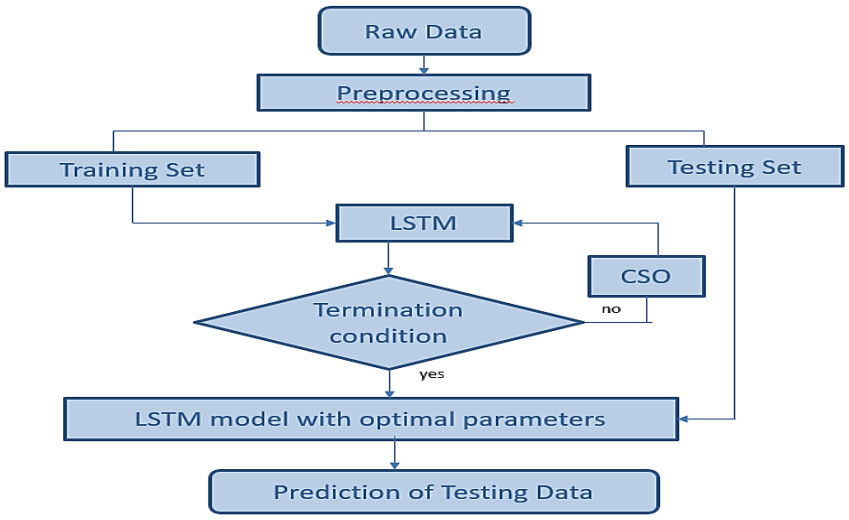

Figure 3.2. Data Flow Diagram

3.3 Data Extraction and Selection:

The output of data transformation procedure is subsequently sent into the extraction step of the technical indicators. In order to get the best forecast outcomes for electricity generation, technical indicators like the Simple Moving Average (SMA) and Exponential Moving Average (EMA) are successfully retrieved the efficient feature extraction and selection parameters.

3.4 Comparison of Energy Forecasting: Based on an LSTM classifier, the chosen feature N is utilised to forecast electricity demand or generation. However, the proposed CSO is used to carry out the LSTM training procedure. Figure 3.2 diagram shows the data flow of the proposed idea. Here, first the data is taken from growth dataset from Central Electricity Board India. The training and testing the data is done by applying the Deep learning techniques then condition is checked if condition gets satisfied then the output is displayed i.e prediction of energy consumption.

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4. IMPLEMENTATION AND RESULTS

4.1 CSO with LSTM Algorithm

CSO with LSTM is a deep learning algorithm used to predict the energy consumption in next years. CSO is used to predict the best accurate values whereas the LSTM is used to take the data set and pre-process it.

4.2 Input and Output

Every year electricity board of India releases energy consumption dataset as a growth book [10]. The data contains the power consumption which has yearly power consumption, monthly power consumption, weekly power consumption and daily power consumption. Taking that data as a data set and passing that data into CSO-LSTM deep learning algorithms to predict the amount of energy consumed in the future years. Forecasting of power consumption shown in Figure 4.1 and so proposed hybrid model achieved higher performance results for energy consumption is calculated to the next five years.

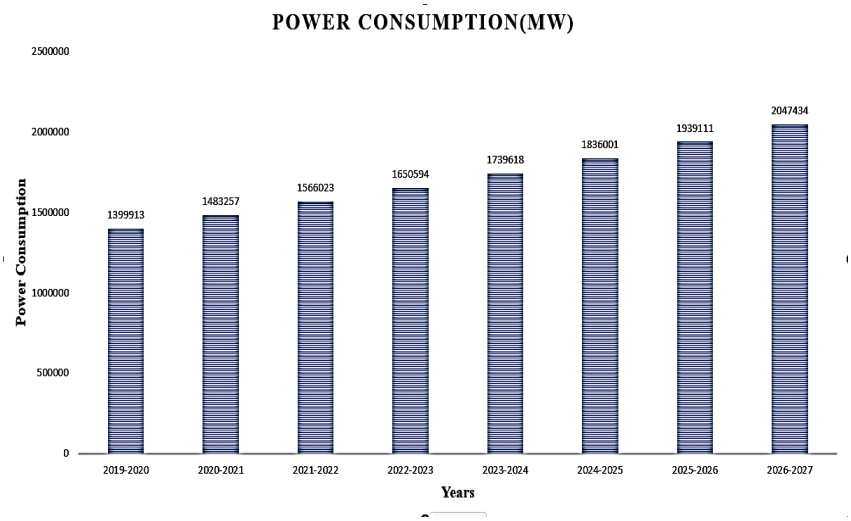

Figure 4.1 Forecasting of power consumption

5. CONCLUSION AND FUTURE WORKS

In this paper the four processes of the suggested approaches such as data transformation, technical indicators, feature extraction and selection, and power consumption of the predicted energy demands. A LSTM classifier that had been trained using the suggested CSO technique was used to anticipate the demand for electricity. Energy demand data is used to forecast future energy consumption using combined the CSO with LSTM deep learning algorithm by 2027.This strategy will

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reduce errors, result in a procedure that is cost-effective, and have a faster convergence rate, which will cut down on training time and increased accuracy. In future, the energy demand will be replaced with the various kind of renewable energy sources and also the long-term forecasting that will be possible to increase the arrangement of future energy demand, energy generation and consumption.

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