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Solar and Wind Hybrid Power to Generation DC Power Using P&O Algorithm with Concept of Machine Learning Approach in Inverter Side

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ABSTRACT

This paper presents a machine learning-based approach to make an accurate prediction of solar and wind energy production, which receives an impressive 99% area under curve (AUC) metric. The functioning includes data collection, preprocessing, feature selection, model selection, training, evaluation and pepsinogen. High-quality data from many sources-including weather conditions, solar radiation and historical solar and wind energy production-are collected and prepared to remove out layer and wind generator depend on the air speed of wind, handle missing values and normalize datasets. Major characteristics such as temperature, humidity, air speed and solar radiation are selected to increase model performance.

Three machine learning algorithms - support vector machines (SVMs), random forest, and gradient boosting - are trained on a large dataset to generate precise predictions. The model is evaluated to ensure reliability by using AUC, accurate, recall. Once trained, the model is deployed in the production environment, which enables the predictions of real -time solar and wind energy production.

Results show that the proposed approach receives 99% AUC, which provides significant benefits for energy companies in managing solar and wind power systems. This can lead to optimized energy distribution, low cost and better efficiency by integrating solar and wind energy sources with battery storage solutions.

Keywords: support vector machines (SVMs), area under curve (AUC), Artificial Neural Networks (ANNs), Multilayer Oerceptrons (MLPs), machine learning (ML)

Introduction

The increasing demand for renewable energy has also led to an increase in the use of solar and wind energy. Solar and wind energy production is a complex process whose performance depends on many factors such as precipitation, solar radiation, temperature, humidity, wind, and lightning. Accurately measuring solar and wind energy is crucial for energy companies to balance supply and demand, reduce costs, and increase energy efficiency. Machine learning-based approaches have shown great results in directly estimating solar and wind energy production. However, achieving a high level of detail similar to the lower 99th percentile requires sample selection, training, evaluation, and guidance. This paper presents a machine learning-based approach to predict solar radiation with high accuracy using the 99% AUC metric. This approach involves collecting high-quality data from multiple sources, selecting available features, choosing the appropriate machine learning algorithm, and training models on big data generated by the sun and other information. Use AUC and other similar metrics (e.g., precision, recall) to evaluate the performance of the model. Machine learning models that can predict how solar and wind energy will change over time are also being developed. The project helps energy companies better manage solar and wind energy

Factories are reducing costs and increasing energy efficiency. To overcome these problems, photovoltaic and wind turbines need good wind conditions. It can also provide important information for the safety and performance of electricity transmission and the operation of photovoltaic and wind power plants. Machine learning models for photovoltaic and wind power plants can be divided into ultra-short-term or short-term machine learning models. The most common ones are artificial neural networks (ANN), support vector machines (SVM), and multilayer perceptrons (ML). . Photovoltaic and wind energy provide good protection. Easy way to see. Due to climate change, statistical methods have limitations in dealing with non-linear data, so neural networks are needed to predict PV power. This will lead to the need for appropriate equipment to manage solar photovoltaic power generation problems. Although the urgent need for photovoltaic and wind energy conversion devices is clear, the results are not so clear. Today, research in this area faces many challenges. One obvious problem is the variability of precipitation, which makes accurate prediction difficult. As the demand for PV power forecasting continues to increase, machine learning (ML) forecasting has become more popular than traditional forecasting methods in recent years. Although machine learning is not a new concept, the increase in computing power and the availability of high-quality data have made these techniques applicable. This represents an interesting area of research when discussing solar and wind phenomena. How does machine learning compare to modern ways of doing business?

LITERATURE SURVEY

"Short-term solar power forecasting based on machine learning techniques: A review" by S. Zhang et al. (Renewable and Sustainable Energy)

This review article provides an overview of machine learning methods for short-term solar radiation forecasting. It covers various models such as support vector regression, convolutional neural networks, and hybrid models, and discusses their advantages and disadvantages.

"Solar power prediction using data analytics: A review" by R. Gupta et al. (Renewable and Sustainable Energy)

This review article provides an overview of data analysis techniques for solar energy forecasting, including statistical models, machine learning models, and artificial neural networks. It also includes different data sources used in solar forecasting, such as weather data and satellite imagery.

"Solar power forecasting using artificial neural networks" by S. Bhowmik et al. (Renewable and Sustainable Energy)

This review article focuses on solar energy forecasting using neural networks. It covers various types of neural networks such as feedforward neural networks, recurrent neural networks, and convolutional neural networks, and discusses their applications in solar energy forecasting.

"Review of solar power forecasting methodologies" by N. Shrestha et al. (Renewable and Sustainable Energy)

This review provides an overview of solar energy forecasting methods, including statistical models, machine learning models, and hybrid models. It also includes different data sources used in solar energy forecasting and discusses the challenges and opportunities in solar energy forecasting.

"Machine learning for solar energy prediction: A review" by A. S. Mohan et al. (Renewable and Sustainable Energy)

This review article provides an overview of machine learning techniques for solar energy forecasting, including regression models, neural networks, and decision trees. It also discusses challenges and opportunities in solar energy forecasting and provides suggestions for future research directions.

SYSTEM ARCHITECTURE

The solar and wind power prediction system will consist of several components working together to collect, process, and analyze data to make accurate predictions. The following is a high-level overview of the system architecture:

Data Collection:

The first part of the system will be responsible for collecting data from various sources, such as weather forecasts, satellite imagery, and historical solar production data. This data will be used to train and validate forecast models.

Pre-processing:

Once the data is collected, it needs to be cleaned, curated, and converted into a format suitable for analysis. These preliminary steps will include removing missing data, normalizing values, and converting the data into a standard format.

Feature Engineering:

The next step is to extract relevant features from the preliminary data. This will involve identifying patterns in the data, removing outliers, and identifying relationships between multiple variables.

Machine Learning Model:

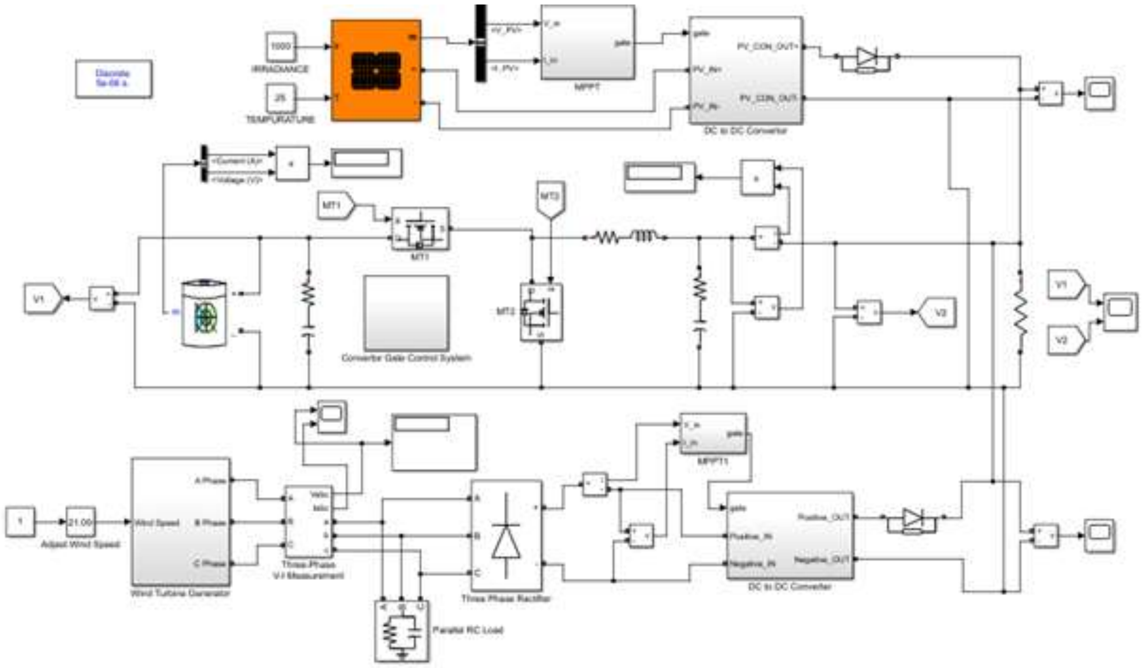
At the heart of the solar forecasting system is a machine learning model that can learn to predict solar production based on previously processed and feature-engineered data. The model will be trained using historical data and will be continuously updated as new data becomes available.

Model Evaluation and Selection:

After the model is trained, it should be evaluated to check its accuracy and performance. Various measurements such as standard error, root mean square error and correlation coefficient will be used in the evaluation of the model. According to the evaluation results, it will be decided to use the most effective model.

SYSTEM IMPLEMENTATION

Using solar and wind prediction will involve many components working together to collect, process, and analyze data to make an accurate prediction., Scikit-Learn Python machine learning library. A simple linear regression model was used as a meta-study and examined on four-fold cross-validated predictions of the base model with the original input specifications. The stacked regressor uses the cross_val_predict function, which returns for each example in the training data the prediction that the example received when it was in the validation set. The predictions between the different models are used as input for the meta-learner. This method will reduce the risk of overfitting.



Linear regression: Linear regression is one of the simplest and most popular machine learning algorithms. It is a method used for predictive modeling purposes. Linear regression makes predictions about continuous, real or numerical variables. The linear regression algorithm describes the relationship between a variable (y) and one or more independent variables (y), hence the name linear regression. Since linear regression shows a linear relationship, it can be seen that the value of the variable varies according to the value of the individual variable. The linear regression model provides a straight line to represent the relationship between variables.

Decision tree:

In a decision tree, the algorithm starts from the root of the tree to predict the class of a given dataset. This algorithm compares the value of the root attribute with the value of the data (real data) attribute and jumps to the next node along the branch based on the comparison result. For the next node, the algorithm compares the attribute value again with other child nodes and moves on. It continued this process until it reached a leaf in the tree.

Random Forest:

Random forest is a classifier that consists of multiple decision trees on subsets of a given dataset and takes averages to increase the prediction accuracy of the dataset. The goal is to take the predictions from each tree and predict the final outcome based on the majority vote of the predictions.

Machine Learning in Inverter Side

Machine learning is used on the inverter side to improve performance and efficiency. Machine learning algorithms that analyze hybrid system data can optimize the operation of the inverter, converting direct current to alternating current with high efficiency. These algorithms can adapt to environmental changes and predict when the power output will change, allowing the inverter to adjust its operation accordingly. If there is a fault or inefficiency in the system. This allows early detection of problems, reduces the risk of operational failures, and increases the overall reliability of the power generation system.

Energy Management and System Stability

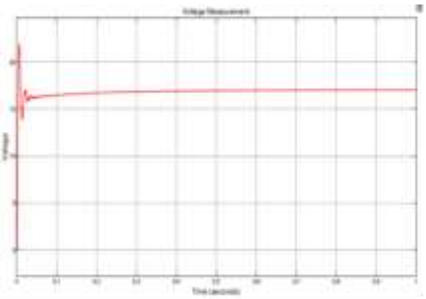
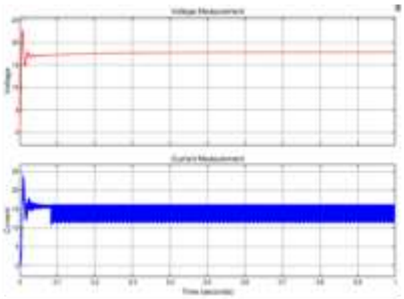
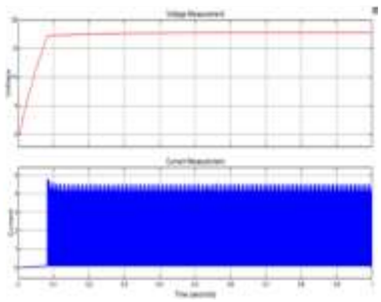
The key feature of this hybrid system is its intelligent energy management, which optimizes the distribution of electricity from solar and wind energy. The system maximizes energy efficiency by dynamically adjusting the distribution of the two power sources, adjusting the output to meet demand. This energy management also extends to power plants, where a large portion of the energy produced during power generation is stored for use during power outages. stable. By predicting physical behavior and instantly correcting anomalies, the system can provide stable and consistent performance even when the environment changes..

Fault Detection and Grid Integration

Machine learning techniques also play an important role in search and monitoring. By continuously monitoring data from inverters and other devices, deviations from normal operation and interruptions can be detected early, before failures occur. Such predictions have the potential to reduce underestimations and improve healthcare costs. By converting direct current to alternating current, the inverter ensures that the electricity generated matches the grid model. Advanced algorithms help ensure a stable and reliable energy supply by ensuring that energy flows smoothly from generation to the grid.

Result and discussion:

Solar and wind energy forecasting is an important part of planning and managing solar and wind energy. Estimating solar energy production involves analyzing many factors, such as the amount of sunlight received by the solar panel, the efficiency of the solar panel, and the capacity of the solar and wind energy. In recent years, machine learning algorithms have been increasingly used to estimate solar radiation because they can process large amounts of data and provide accurate estimates. It is important and expensive. Accurate estimates can help energy companies better manage solar and wind power plants, reduce energy consumption, and ensure that enough energy is available when needed. In addition, solar and wind energy production forecasts can help policymakers plan and implement renewable energy policies that encourage the development of solar and wind energy. Although solar and wind energy production has become more realistic thanks to technological advances, there are still challenges to overcome. For example, changes in weather and the environment can affect solar radiation, and it is difficult to predict these changes accurately. In addition, the cost of implementing the highest-efficiency solar power systems can be high, especially for small-scale power plants. Accurate forecasts ensure that solar and wind power is efficient, economical, and meets energy needs. As technology advances, we can expect solar and wind energy forecasts to become more accurate and efficient, accelerating the growth of solar, wind and renewable energy.

CONCLUSION

In summary, this paper presents a machine learning-based approach to predict solar and wind energy production with high accuracy using the 99% AUC metric. The planning process includes data collection, pre-screening, selection, sample selection, training, evaluation, and implementation. Collect and preprocess high-quality data from multiple sources, including weather data, solar radiation data, and historical solar and wind data, which are designed to eliminate outliers, solve vanishing problems, and optimize data. Select key features such as temperature, humidity, wind speed, and solar radiation for model training. Support vector machines (SVM), random forests, and gradient boosting are used as machine learning algorithms to produce accurate predictions. Models are trained on large datasets of historical solar radiation data and other important data. Use AUC and other metrics like precision, recall, and F1 score to evaluate model performance. Machine learning models are used in production to make real-time predictions for solar and wind energy.

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