Research and application based on the swarm intelligence algorithm and artificial intelligence for wind farm decision system

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Wind energy is an increasing concern for wind farm administrators. Effective wind energy potential analysis and accurate forecasting can reduce the operating cost of wind farms. However, many previous studies have been restricted to analyses of wind energy potential analysis and wind speed forecasting, which may result in poor decisions and inaccurate power scheduling for wind farms. This study develops a wind energy decision system based on swarm intelligence optimization and data preprocessing, which includes two modules: wind energy potential analysis and wind speed forecasting. In the wind energy potential analysis module, the parameters of the Weibull distribution are optimized by a multiple swarm intelligence optimization algorithm, which can provide better wind energy assessment results. In the wind speed forecasting module, the data preprocessing method can effectively eliminate the noise of the original wind speed time series, maintain the characteristics of the wind speed data, and improve the accuracy of the forecasting model. The numerical results show that the wind energy decision system not only provides an effective wind energy assessment, but can also satisfactorily approximate the actual wind speed forecasting. Therefore, it can serve as an effective tool for wind farm management and decision-making.

A Comprehensive Review of Artificial Intelligence and Wind Energy.

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Support of artificial intelligence, renewable energy and sustainability is currently increasing through the main policies of developed countries, e.g., the White Paper of the European Union. Wind energy is one of the most important renewable sources, growing in both onshore and offshore types. This paper studies the most remarkable artificial intelligence techniques employed in wind turbines monitoring systems. The principal techniques are analysed individually and together: Artificial Neural Networks; Fuzzy Logic; Genetic Algorithms; Particle Swarm Optimization; Decision Making Techniques; and Statistical Methods. The main applications for wind turbines maintenance management are also analysed, e.g., economic, farm location, non-destructive testing, environmental conditions, schedules, operator decisions, power production, remaining useful life, etc. Finally, the paper discusses the main findings of the literature in the conclusions.

Detection of Cracks and damage in wind turbine blades using artificial intelligence-based image analytics

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Image processing involved specifically with image recognition and image classification has taken a huge stride with the advent of high-performance GPU's and the increase in the processing speeds of images by the computer systems. Also, the availability of huge datasets on different classes of images has helped in solving issues which can be addressed by huge number of annotated datasets in teaching a supervised Convolutional Neural Network (CNN) model to classify the images. The present method of Structural Health Monitoring (SHM) of Wind Turbine Blade (WTB) inspection manually is involved with a great amount of risk and also takes a lot of time for inspection of each turbine and the operation time of each turbine comes down as the turbine should be at halt while inspecting. These problems are overcome by the inspection through drones and the basic idea of this research is to use deep learning with keras frame work written in python working on top of tensor flow to use the drone captured images to train a neural network model and classify into faulty and not faulty images of blades, which when deployed can be used in classifying new images. This method in turn reduces the maintenance time and inspection time and less risk for the inspection of WTB and in turn the SHM. In this research CNN's are used to find whether the given image of WTB is having damage or not. Since the image data of wind turbine blades are not available easily with annotated images as like ImageNet and AlexNet, this project was developed from scratch right from acquiring the image data. Along the way, the focus was on the influence of certain hyper-parameters and on seeking theoretically founded ways to adapt them, all with the objective of progressing to satisfactory results as fast as possible. In the end, also a promising attempt in classifying WTB damages into a few different classes is presented and deploying the saved model using Flask such that the model can be used anywhere when required. Accuracies of around 94.94% for binary fault classification and 91% accuracy for multiple class fault classification has been achieved. The significance of the proposed method is that it is the first of its kind for WTB damage classification and detection for different classes of damage without using transfer learning but by training the model from the image dataset prepared by image augmentation methods and manual editing.

Towards next generation Savonius wind turbine: Artificial intelligence in blade design trends and framework.

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Currently, the Savonius wind turbine (SWT) has established itself as a reliable wind turbine solution, particularly for small-scale wind farms. It is a reliable form of power generation owing to its self-starting capability, lack of reliance on wind direction, and low vibration and noise. As a result, it has been gaining popularity worldwide. The main technological challenge in this field, however, is the inferior efficiency of Savonius turbines compared to their other counterparts. A large number of studies have been conducted to enhance the power coefficient of SWT. These studies primarily focused on blade profile and augmentation strategies using simulation-based optimization approaches. Some recent studies, in contrast, have attempted to integrate Artificial Intelligence (AI) into the SWT optimization method. However, to ensure the maximum efficiency and commercial feasibility of SWTs, additional strategy is required. Based on previous and current research trends, this review presents a next-generation SWT blade design framework. The importance of AI in output optimization at low computing costs has been emphasized. Finally, future design concerns have raised the possibility of using a smart blade and digital twin model to enhance the efficiency of SWT blades. Moreover, the existing roadblocks and their possible solutions are also highlighted.

A Hybrid Wind Speed Forecasting Method and Wind Energy Resource Analysis Based on a Swarm Intelligence Optimization Algorithm and an Artificial Intelligence Model.

AUTHOR: Tongulin fu.

Wind power has the most potential for clean and renewable energy development. Wind power not only effectively solves the problem of energy shortages, but also reduces air pollution. In recent years, wind speed time series analyses have increasingly become a concern of administrators and power grid dispatchers searching for a reasonable way to reduce the operating cost of wind farms. However, analyzing wind speed in detail has become a difficult task, because the traditional models sometimes fail to capture data features due to the randomness and intermittency of wind speed. In order to analyze wind speed series in detail, in this paper, an effective and practical analysis system is studied and developed, which includes a data analysis module, a data preprocessing module, a parameter optimization module, and a wind speed forecasting module. Numerical results show that the wind time series analysis system can not only assess wind energy resources of a wind farm, but also master future changes of wind speed, and can be an effective tool for wind farm management and decision-making.

Artificially intelligent models for the site-specific performance of wind turbines.

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Power developed by the wind turbines, at different wind velocities, is a key information required for the successful design and efficient management of wind energy projects. Conventionally, for these applications, manufacturer’s power curves are used in estimating the velocity–power characteristics of the turbines. However, performance of the turbines underactual field environments may significantly differ from the manufacturer’s power curves, which are derived under ‘standard’ conditions. In case of existing wind projects with sufficient performance data, the velocity–power variations can better be defined using artificially intelligent models