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Artificial intelligence based forecast models for predicting solar power generation

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Abstract

Carbon discharges from monetary movement proceed to rise and India is the third-biggest emitter among individual nations. The Renewable Energy is the way forward and the problems in harvesting it should surmount through policy and technical approaches. The prime disadvantage with most of the Renewable Energy resources is their susceptibility to the whim and vagaries of nature and becoming a variable random source of power. Predicting the power from these variable power sources define and determine the operation of the system. In this paper, ANN and ANFIS based forecast model for predicting the PV Generation are presented. The designed forecast model is trained using historical data. The results of the proposed model are validated and compared by considering data set of PV power generating station. A simulation model of proposed system is developed in MATLAB to evaluate the system performance.
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1. Introduction

Energy is basic, specifically or by implication, in the completetechnique of advancement, expansion and existence of all living being and it shows a fundamental part in the monetaryprogress and human prosperity of a nation. Energy has come to be known as a vital produce and any liabilityaround its source can weaken the operational of the economy, specifically in emerging economies.

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Realizing energy safety in this important sense is of essential prominence to India's monetaryprogress as well as for the socialprogress destinations that go for the mitigation of neediness, unemployment and meeting the Millennium Development Goals [1].Because of thepresent situation of energy utilization, India is progressively moving the attention towards its renewable energy sources. The launch of Jawaharlal Nehru National Solar Mission (JNNSM)has made a considerable measure of enthusiasm for the India solar segment. To make arequest and draw in interest in the part, the government is giving different impetuses.

India's solar photovoltaic market has developed by 75% in 2010 and a half in 2011. India has tremendous potential for sunlight based PV and with the right arrangement support from the Indian Government; India can turn into a noteworthy player in the solar market all around. One of the primary components of the Mission is to make India a worldwide pioneer in solar power generation and the mission predicts an installed solar power generation limit of 20 GW by 2022. This could really be much bigger because of private activities [2]. India is blessed with affluent solar energy resources. Due to its position between the Tropic of Cancer and the Equator, India has a normal yearly temperature that extent from 250C – 27.50C. Being a tropical nation, India has immense potential for PV power generation. The usual intensity of solar radiation in India is 200 MW/km^{2}through 250–300 sunshiny days in a year. According to government guesses, India gets 5,000tn kWh every year, with maximum parts of the nation getting 4-7 kWh per square meter every day [3].According to IEA projection,India will need 327 GW power generation capacities in 2020.

Predicting the output of these renewable sources is a critical issue for electricity departments to alter dispatch arranging in time, increase the reliability and reduce spinning reserve capacity of generation systems[4, 5]. In the existing literature; solar powerpredicting has been widely studied. Short-term power prediction methods for solar power plants primarilycomprise two classes: physical methods and statistical methods. Physical methods imply that a physical equation is established for prediction rendering to the solar power generationprocedure and system characteristics and in combination with forecast weather data [6, 7]. Statistical methods intention to summarize inherent laws to predict the solar power based on historical power data [8, 9, 10, 11, 12 and 13]. The above methods have their respective advantages, but the non-stationary characteristics of solar power output have asignificanteffect on the convergence and properties of the above methods.

From the time when solar irradiance got at a site on the Earth's surface shows periodicity and non-stationary characteristics because of the impact of Earth's rotation and revolution, output power data of solar plants indicates one-day periodicity. As it were, the output power shows a rising pattern before twelve and presents a declining pattern evening. If an effective method to decrease the non-stationary characteristics of solar output power is not implemented, Traditional solar power prediction methods cannot promise the exactness of forecasting outcomes or even the convergence of the method [14].

Artificial intelligence techniques have been viewed as a convenient way to forecast solar power generation. In this work a comprehensive model to predict the solar power output based on historical data is presented. The work explores the option of using Artificial intelligence based methods like Artificial Neural Networks (ANN) and an Adaptive Neuro-Fuzzy Inference System (ANFIS) for predicting the power output. Artificial intelligence based methods are naturally flexible and capable of dealing with non-linearity. They do not need any previousmodelingknowledge and the workingproceduresinevitablycategorize the input data and associate it with the respective output values. They are ‘black box’ kindapparatuses and to a great extent do not agree for comprisinginformation of physical relationsamong model constituents.

2. Determination of input variables for the power forecasting model

Normally, adequatelyexact solar irradiance data can be input into a formula to derive predicted output power. Predicting power output from renewable energies is closely connected to weather forecast predictions. To predict the amount of solar irradiance or power generated, various environmental factors, such as solar irradiance, cloud cover, atmospheric pressure, and temperature, along with the conversion efficiency of PV panels, installation angles, dust on a PV panel, and other random factors must be considered. All these factors affect PV system output. Hence, in choosing input variables for a prediction model, one should consider deterministic factors strongly correlated with power generation. Additionally, time-series data for PV power generation are strongly autocorrelated and therefore these historical data should be the input data of the forecasting model.

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