

Support vector machine for hourly solar irradiance prediction

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Abstract:

Renewable energy technologies are clean sources of energy that have a much lower environmental impact than conventional energy generation methods. Researches focusing on different energy generation techniques are gaining much importance worldwide, to manage exponential increase in the energy requirements. Solar energy is used in various applications like solar charged sensor nodes, solar charged vehicles, agriculture, electricity production etc. This solar energy can be harnessed using a range of technologies such as solar heating, solar photovoltaic cells, solar thermal electricity, solar architecture and artificial photosynthesis. The need for solar energy requires the estimation of solar energy production at various atmospheric conditions. This estimation involves the prediction of solar irradiation. Machine learning techniques based on Support Vector Machine (SVM), Neural Networks, Multilayer Perception(MLP), etc as well as Gaussian Process Regression method are normally applied for learning and predicting solar parameters.

Keywords: Atmospheric, SVM, MLP, Thermal.

1. INTRODUCTION

The solar irradiation data provides information on how much energy is present at a specific location on the earth during a specific time period[1]. These data are required for designing solar energy systems. Solar energy is available throughout the year and also it is secure and clean. So the cleaner renewable solar energy can be replaced in various applications using fossil fuels when there is a shortage or raise in cost of fossil fuels like coal, oil and natural gas[1]. To make use of available solar energy efficiently, the energy can be harnessed using a range of technologies such as solar heating, solar photovoltaic cells, solar thermal electricity, solar architecture and artificial photosynthesis. There will be continuous need of energy for the applications using solar energy. This calls for the estimation of available solar energy and the estimation involves the prediction of solar energy. Machine learning techniques based on Neural Networks, Support Vector Machines(SVM) are used to predict the global solar irradiation. The parameters used in the prediction model are average air temperature, average wind speed, current wind direction, average relative humidity, total rainfall, maximum peak wind gust, current evaporation, average absolute barometer, average solar radiation Machine Learning techniques based on Neural Networks, Support Vector Machine(SVM) are found to provide less accurate prediction values The solar irradiation can be predicted using a wide range of meteorological data. The collected solar irradiation data may contain too much of information out of which only a few data are required for daily global solar irradiation prediction[3]. Also the use of noisy data will lead to failure in the prediction process. The noisy, irrelevant and redundant data from a wide-range of datasets can be reduced and

filtered using various techniques. like kalman filter. Now, the preprocessed data can be used to predict the daily global solar irradiation for more accurate results.

2. RELATED WORK

An advanced model for estimation of surface solar irradiance from satellite (AMESIS) has been developed to estimate the incident solar radiation at the surface from the spinning enhanced visible and infrared imager (SEVIRI) satellite measurements. In Hidden Markov Model (HMM) with Pearson R model was utilized for the extraction of shape based clusters from the input meteorological parameters and it was then processed by the Generalized Fuzzy Model (GFM) to accurately estimate the solar radiation.

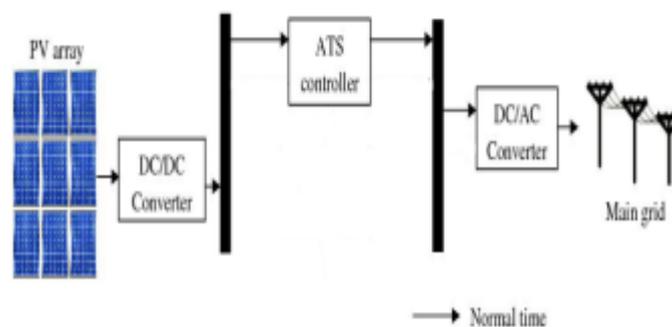


Fig.1.System Representation

The Coral Reef Optimization algorithm has been designed in such a way that the Extreme Learning Machine solves the prediction problem, whereas the Coral Reef Optimization evolved the weights of the neural network, in order to improve the solutions obtained. Support Vector Machine is a supervised machine learning technique, which is used for binary classification of the input into different sets after training the model with previous data. It can work in multiple dimensions represented by different variables. The Support Vector Machine has been used particularly in the classification of two different categories of patterns. It is based on a kernel method and is used for classification / regression, reducing dimensionality or clustering. In a simple linear regression technique such as minimizing least square error, the decision to select a regression function for the input data is based on fitting a line that minimizes the total square error for the entire data-set. Its goal is to minimize the average distance between the two clusters and the hyperplane which is equivalent to identifying a hyperplane having the maximum distance from the nearest data point from both the clusters.

3. PROPOSED SYSTEM

Machine learning is a subdivision of artificial intelligence that is developed as a result of studies in pattern classification and recognition for finding mathematical models for various real life problems. Machine learning investigates the construction of algorithms that can learn from the previous data and help in finding a forecast on the data in the current and future time. The machine learning applied iterative and interactive statistical methods in the construction of computational models to obtain the desired results. The factors like efficiency of learning algorithms, the complexity of the problem, methods of representation of data are the most important factors affect the accuracy of the results and future forecasting for data. There is number of studies in literature related to the use of machine learning techniques to predict PV performance, including Multilayer Perceptron (MLP) network, Probabilistic

Neural Networks (PNN), General Regression Neural Networks (GRNN), Radial Basis Function networks (RBF), Cascade Correlation, functional link networks, Kohonen networks, Gram-Charlier networks, learning vector quantization, Hebb networks, Adaline Networks, hetero Associative Networks, Recurrent Networks, and hybrid networks. implements a SVM model to estimate the daily solar radiation using air temperatures. The developed SVM model used a polynomial kernel function which performed better than other SVM models.

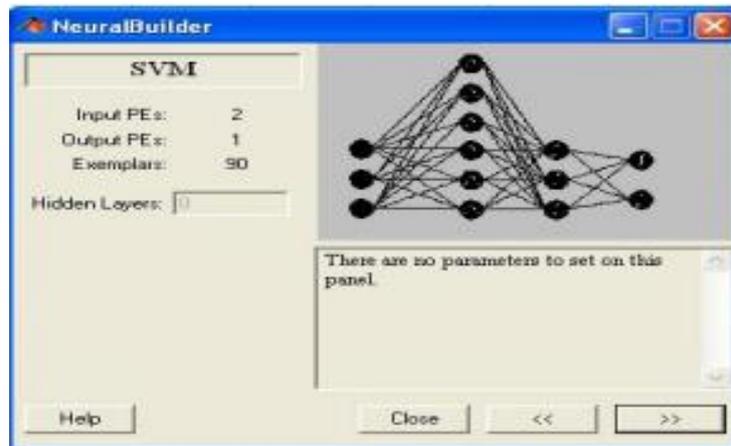


Fig.2. Sample structure

He obtained a highest NSE of 0.999, and the R-square of 0.969, while the lowest RMSE is 0.833 and RRMSE of 9.00. In this study, SVM model will be proposed for solar PV system in Sohar, the second largest city in Oman, based on experimental data for solar irradiations and installed PV system in the Solar Cells and Photovoltaic Research Lab in Sohar University, Oman. This paper aims to discuss and implement machine learning methods for acceptable management of the energy generation of a PV system.

Sohar is the second largest city in Oman after the capital, Muscat. It is the primary industrial center which is just 230 km from Muscat, the capital. The solar radiation intensity in Solar (Direct normal (DNI), diffuse horizontal (DHI) and global horizontal (GHI)) was measured and recorded experimentally. The measurements revealed that higher solar irradiance in summer (July) where the maximum irradiation recorded value was 950 W/m² at 1 PM, and the minimum ones was 202 W/m² in January at the same hour.

4. ANALYSIS

It is concerning with the techniques and methods that help the machine to learn. Machine learning is developed as a result of studies in pattern classification and recognition for finding mathematical models for various problems. Machine learning investigates the construction of algorithms that can learn from the previous data and help in finding a forecast on the data in the current and future time. The machine learning applied iterative and interactive statistical methods in the construction of computational models to obtain the desired results. COLT-92 as presented in Figure 4. It is considering as a classification and regression prediction techniques. SVM is deployed in many applications, such as face analysis and detection, hand writing recognition, pattern classification and regression etc. A classification technique comprises of training and testing data attributes. The main benefits of SVM are minimizing the classification error by implement an iterative training algorithm and maximizing the margin between two hyper-planes. The SVM is applied using the Neuro-Solutions software package. The SVM utilizes different types of kernels which include linear, polynomial, and Radial Basis Function

(RBF). The non-linear information will convert into a linear form by mapping them into a high-dimensional space.

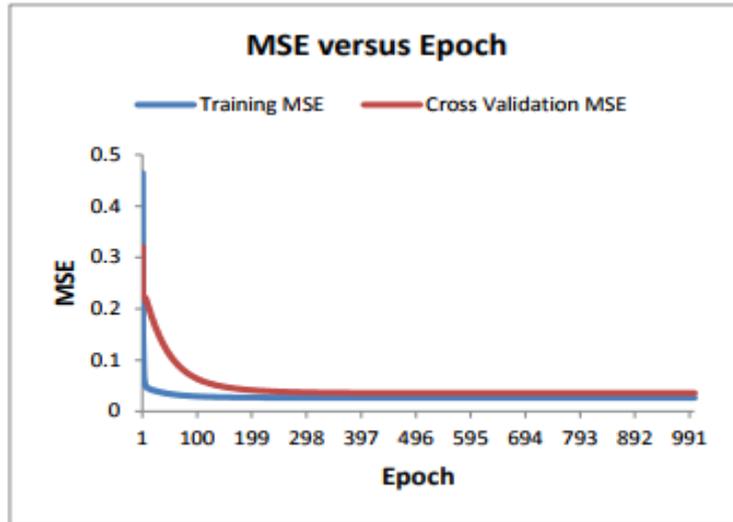


Fig.3.output wave

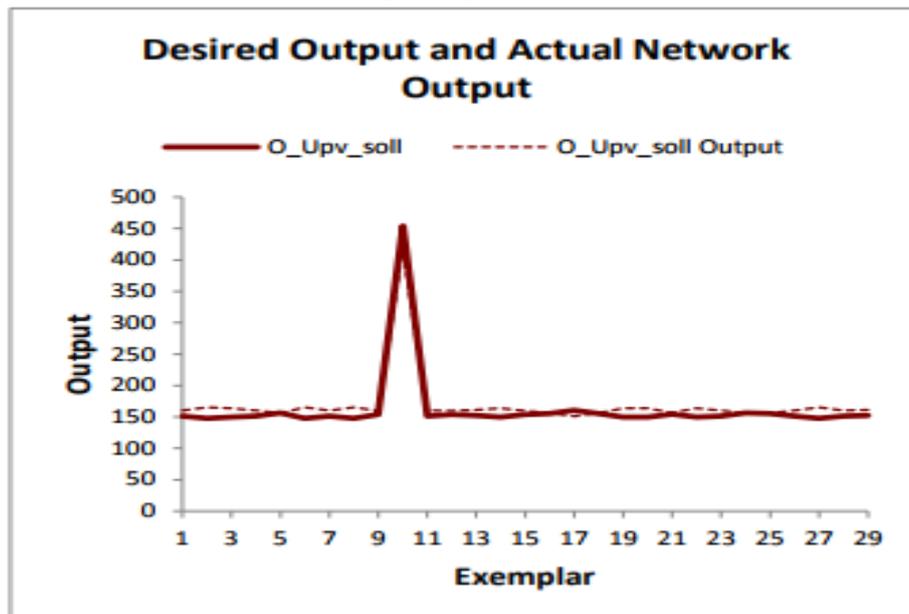


Fig.4.Cross spike

Then, only the closet data to the decision zone is choosing. Moreover, in order to have a good generalization the Neuro-Solutions software package utilizes the large margin classifiers in the training phase. A large positive MSE means a large deviation in the predicted value from the real value. The developed model found to be able to predict the individual values since its MSE is 0.035. Also, Table 3 illustrates a comparison of MSE for the proposed model and models in literature, which shows that the proposed model is more accurate than other models in China, UAE and Malaysia. Also, it is found that SVM is more efficient in comparison with other ANN models.

CONCLUSION

A prediction model of solar photovoltaic system using SVM has been proposed for Oman. This prediction was based on collected data from installed system in location called Sohar. Two inputs solar

radiation and ambient temperature has been used and one output, photovoltaic current. The developed model has been evaluated using MSE. Results show that the predicting model is very close to the regression line and a well data fitting to the statistical model. The MSE found to be 2.6%, which is more accurate in comparison with some studies in literature.

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