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# Predicting the Power Output of a Grid-Connected Solar Panel Using Multi-Input Support Vector Regression

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**Abstract**

As the penetration of photovoltaic power is increasing, utilities are concerned about its impact on distribution grid. Due to the variable nature of solar power, predicting the power output of solar panel installation is important for its optimal use. This paper proposes a new method for forecasting the power output from a solar panel using multi input Support Vector Regression model. The performance has been analysed and compared with Analytical PV power forecasting model. Both the models are simulated and performance evaluation is done using MATLAB. Mean Absolute Percentage Error and Mean Absolute Error are used to assess forecasting models.

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*Keywords:* Support Vector Regression(SVR);solar irradiance;Photovoltaic(PV) installation; Mean Absolute Percentage Error(MAPE); Mean Absolute Error(MAE)

## 1. Introduction

Usage of solar panels for power production has significantly increased due to its high efficiency and the subsidies provided by the governments, for the installation of solar panels[1]. In present scenario solar energy is directly fed to

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the grid without checking the status of the grid. This is possible since the power generated from the distributed solar panels doesn't exceed the limit of penetration of grid. However, in future almost every house will be installed with solar panels and the distributed solar power penetration to the grid will be higher[2]. But the grid is not designed such as to integrate large amount of varying solar power into it. So in order to face this issue and to control the excess power utility should have an estimate of how much amount of solar power will be adding to the grid. If we can predict the power output from every solar panel that are connected to the grid and inform it to the utility, utility will know how much amount of power will be adding to the grid at a particular time. This will assist the utility to make use of these resources to its maximum and maintain the stability of the grid. Predicting the power output of a solar panel also helps in optimal load scheduling, bidding in electricity markets etc. But the power output from a solar panel can change rapidly due to passage of clouds or variation in temperature. This makes forecasting the power output of a solar panel even more challenging task.

In this paper a new solar power forecasting method based on SVR is proposed. Analytical power forecasting approach is used as the reference model for performance evaluation. Both the models are simulated in MATLAB and an error analysis has been done. This project can be extended by implementing the power prediction algorithm in hardware and informing predicted value to the utility. Intelligent energy management can also be included to make optimal use of solar power.

## 2. Background study

Mainly there are two approaches for forecasting solar power. They are statistical approach and physical approach. Physical approach is done by using weather data and statistical approach is done by using historical time series of data. Hybrid methods are also available for forecasting solar power. In early stages, studies were more based on prediction of solar irradiance. In later studies prediction of solar power got more prominence.

A well known physical approach for solar power forecasting is analytical PV power forecasting method which is based on appropriate theoretical models[3]. This method uses equations for calculating the solar irradiance falling on earth. Empirical formulas were used to calculate solar power using solar irradiance. Cloud conditions and atmospheric turbidity were considered while calculating power. Analytical model is used as a reference to analyze a new multilayer perceptron PV forecasting model in [4]. Both short-term power forecasting models were used to predict hourly values of power generated from the solar panel.

Methods based on weather patterns are introduced in [5]. Two short term power prediction models are analyzed using different weather patterns. An adaptive network based forecasting model (NARX) network is used in [1] to predict the solar PV power output. This model will adapt to the variations in climatic conditions since it is trained in real time. Weather forecast data from public websites are taken to know cloud status in future days. This will help the model to adapt with the possible weather changes that can happen in next hour. In [6] statistical methods based on multiregression analysis and the Elmann artificial neural network (ANN) are developed in order to predict power of a PV plant. This model was trained using three different input vectors. First input vector only includes solar power data, second vector consists of both solar power data and solar irradiance. Third vector contains solar power data and temperature data along with solar irradiance. Best predication was done when the third vector is used for training the model.

## 3. Methodology

A comparative study has been conducted between the proposed model and the reference model. PV power forecasting method based on SVR which can be considered as a statistical approach is the proposed model and Analytical method which is a physical approach is chosen as the reference model. In order to find out which is more optimized method for predicting the solar panel power output both the models are implemented and simulated in MATLAB.

- Project site details: The test input data was obtained from a rooftop grid-connected PV system located in Amrita Vishwa Vidyapeetham in Ettimadai, Tamil Nadu (10.9002° N, 76.9026° E) installed in the year 2012. There are 8 panels with rated power 68W each. The solar panel inclination angle is 11°. The altitude of the place is about 0.323 km.

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