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Design, Construction and implementation of Artificial Intelligence Technique for better performance of a Solar Wind Hybrid System

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ABSTRACT: As the dependence on fossil fuels is decreasing, and need for clean and renewable sources of energy are being preferred, solar energy has turned to be the most effective among all of the renewable sources. The major challenge with tapping solar energy using solar cells is the variable and intermittent nature of solar energy. The maximum power point tracking (MPPT) is the technique to maximize the output of the solar panels. While conventional technique have been used for attaining the condition of MPPT, off late neural networks have been used as the mathematical model to optimize the values of voltage and currents of the panel in order to attain the condition of MPPT. To improve the output of solar wind hybrid system, we use the Artificial intelligence technique.

KEYWORDS: Maximum Power Point Tracking (MPPT), Solar Irradiation, Artificial Neural Networks, Levenberg Marquardt algorithm, Mean absolute percentage error, Accuracy..

I.INTRODUCTION

The world is moving towards rapid advancement in technology and digitization. The requirement of energy has increased manifolds. It is an important element of today's life. The energy can be categorized mainly into two types that are- Renewable and non-renewable sources. The renewable sources of energy can be renewed and created whereas the non-renewable ones shall deplete with extensive use. Proper use of the renewable energy resources has to be planned with prudence. Still many of the industries and factories in the world rely on the non-renewable energy sources. Like the fossil fuels are extensively utilized by the power sector. But not only these fuels are on the verge of depletion but also their use poses harmful impact on the environment and ecology. The unsustainable nature of the fossils creates need for an alternative nature friendly energy sources. Henceforth renewable energy resources are the need of the world today.

In this paper, Proper and adequate renewable energy production and feasibility of usage is required to make it more widespread and prevalent. Solar power is one of the most reliable renewable sources of energy and holds strong potential for harnessing energy from it. If used in an effective method, it can aid in meeting high energy requirements in today high energy demanding economy. But one of the flipsides to the solar power energy is its uncertainty of the measure of energy that can be actually obtained. Among all the renewable resources of energy, like wind energy, geo thermal energy and tidal energy, the energy from solar power is subjected to the most fluctuations and variations as the solar irradiation keeps on changing and varying with time owing to various reasons related to natural phenomenon.

II.SYSTEM MODEL AND PROBLEM DOMAIN

The demand for energy is increasing manifold with each continuously while the supply doesn't grow at that pace. The renewable are at present the favorites to replace fossil-based plants due to abundance in nature and pollution free nature. Following are some of the advantages of solar PV systems:

- Such systems are static devices has no moving parts make them service and maintenance free and easy to mount.
- One can buy and install PV System easily and according to required specification of output.
- Such systems output can easily be increased by adding more modules either in series to expand the system's voltage or in parallel to enlarge the current.
- Such systems are designed with high durability to withstand high temperature, humidity, wind speed and moisture, or rugged condition.

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- Such Systems can have storage capability to give consistent, high-quality power output even when the sun isn't shining.
- Such systems cause no noise or pollution making them eco-friendly.

The disadvantages of solar PV systems are:

- Very costly components required.
- Dust get collected on its surface will affect the output generated hence require regular cleaning.
- Maximum power point of PV cell changes with connected load hence difficult to achieve.
- They have poor efficiency due to bad energy conversion ratio.

III. PROPOSED METHODOLOGY

Importance of Non-Conventional Sources of Energy- Due to growth in population of human and other the technology revolution demanding lots of consumption of power, the global requirement of electricity is sky high these days. Nonrenewable sources have been extensively used over the past decades that they need to conserved now and also use of fossil fuels have turned out to be major causes of greenhouse gas emissions and an trigger global warming. Hence we are left with renewable sources of energy as the most viable and beneficial option for meeting the energy demands.
Solar Energy is one of such clean sources of renewable energy that can ensure securing and fulfilling the future abundant energy needs. It has promising prospects in India.
If we look at the present scenario, there is nearly 1 ton capita per year emission of carbon dioxide in India. The main reason behind it is burning of the fossil fuels. Hence it has become the need of the hour to start using renewable sources of fuels like the wind energy. Solar Energy is one of the most potentially strong and cleaner source of power. The solar irradiation is a natural occurrence and is dependent on various other nature bound parameters like the temperature, humidity, pressure, place et al. But one of the main areas of concern for solar power generation is that fluctuations and variations in solar irradiation directly cause the solar power generated to vary and change.
Artificial Neural Networks used to improve the performance of solar wind hybrid system.

The mathematical model of the ANN is given below:

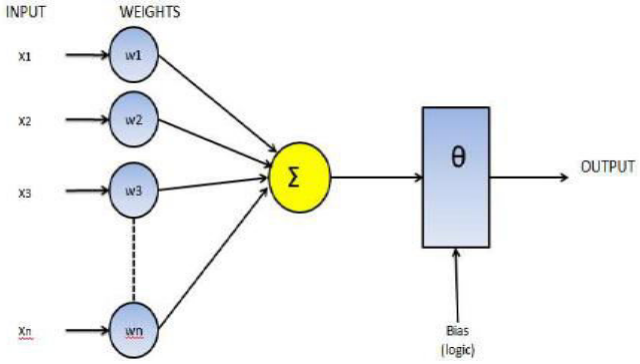

Fig. The mathematical model of the neural network

The governing equation of the neural network can be summarized as:

$$y = \sum_{i=1}^{n} X_i . W_i + \theta_i$$

Here,
X represents inputs
Y represents output
θ represents bias
W represents neural experiences or weights
The neural output time series prediction is a function of both the data that is used for

Training and weights i.e.

$$y(t) = f(x, w_k)$$

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Back Propagation and the Levenberg–Marquardt (LM) Algorithm:

In this technique, there is a feedback path from the output towards the input which carries the error feedback.

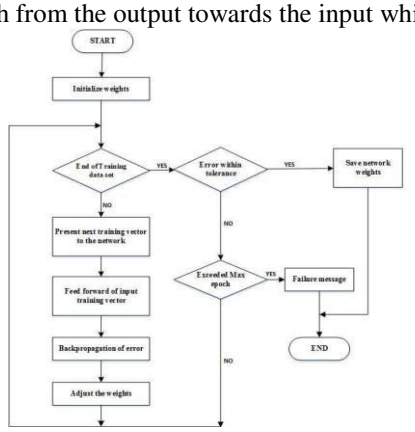

Fig.- Flow diagram of Back Propagation

Although there are several back propagation algorithms, one that is extremely well suited for time series predictions is the LM algorithm being fast as well as stable in terms of error fluctuations.

IV.SECURITY

Spectrum sensing: Detecting unused spectrum and sharing it, without harmful interference to other users; an important requirement of the cognitive-radio network to sense empty spectrum. Detecting primary users is the most efficient way to detect empty spectrum. Spectrum-sensing techniques may be grouped into three categories:
Transmitter detection: Cognitive radios must have the capability to determine if a signal from a primary transmitter is locally present in a certain spectrum. There are several proposed approaches to transmitter detection:
1. Cooperative detection: Refers to spectrum-sensing methods where information from multiple cognitive-radio users is incorporated for primary-user detection.
2. Interference-based detection.
Since primary user networks have no requirement to change their infrastructure for spectrum sharing, the task falls to CRs as secondary users to detect the presence of primary users through continuous spectrum sensing. Spectrum sensing by CRs can be conducted either individually or cooperatively. Recently, the efficacy of cooperative spectrum sensing has gained a great deal of attention. There are several advantages offered by cooperative spectrum sensing over the non-cooperative methods. However, due to the randomness of the appearance of PUs, it is extremely difficult to achieve fast and smooth spectrum transition leading to limited interference to PUs and performance degradation of SUs. Locally collected and exchanged spectrum sensing information is used to construct a perceived environment that will impact CR behaviour. This opens opportunities to malicious attackers. In cooperative spectrum sensing a group of secondary users perform spectrum sensing by collaboratively exchanging locally collected information. Malicious secondary users may take advantage of cooperative spectrum sensing and launch attacks by sending false local spectrum sensing results to others, resulting in a wrong spectrum sensing decision. Two known security threats in CRs are Selfish Primary User Emulation (SPUE) and Malicious Primary User Emulation (MPUE) attack. These types of attacks emulate signals with the characteristics of incumbent primary users to fool other secondary users.

SPUE: In this attack, an attacker's objective is to maximize its own spectrum usage. When selfish attackers detect a vacant spectrum band, they prevent other secondary users from competing for that band by transmitting signals that emulate the signal characteristics of primary user signals. This attack is mostly carried out by two selfish secondary users.

MPUE: In this attack, the objective is to obstruct the DSA process of SUs- i.e., prevent SUs from detecting and using vacant licensed spectrum bands, causing denial of service.

Using the Trust-Worthy algorithm it defines a threshold value to the SUs to overcome the PUE attacks. It enables CR-Networks nodes to efficiently utilize the available spectrum channels. Nodes, which can easily find various licensed channel opportunities without interfering the primary system increases. This reveals that it has a potential to be able to convert the various network conditions into a performance improvement.

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V. RESULT AND DISCUSSION

The model has been simulated on MATLAB 2017a primarily due to the availability of standard training algorithms as in build functions. The results obtained are put forth sequentially.

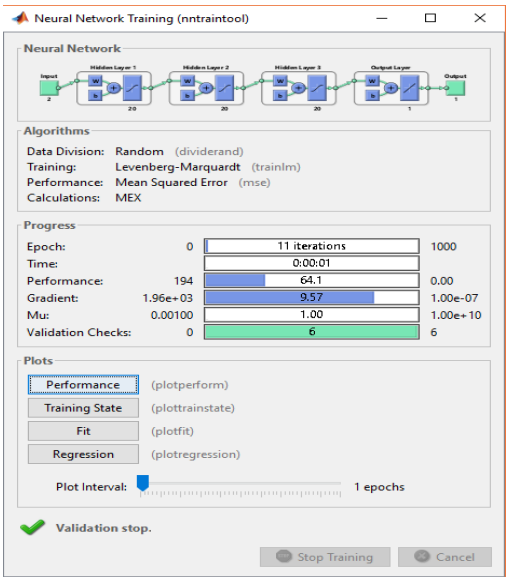

Fig. - Designed Neural Network with training parameters

The training is stopped once the MSE stabilizes and the validation checks are carried out successfully. The mentioned concept is implemented and shown in the figure below.

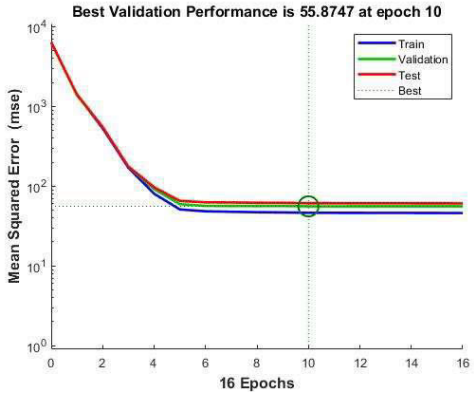

Fig. - MSE variation as a function of iterations

In above graph depicts the variation of MSE w.r.t. epochs and it can be seen that as the error stabilizes, training stops. The mse for training, testing and validation have been shown.

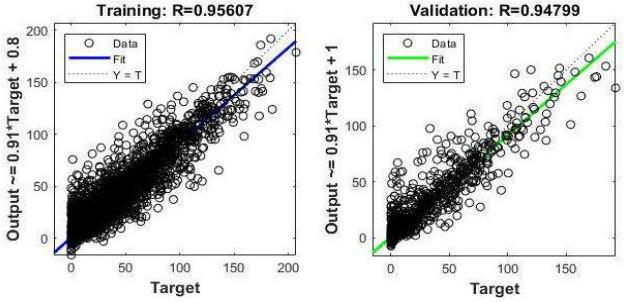

Fig. - Regression analysis

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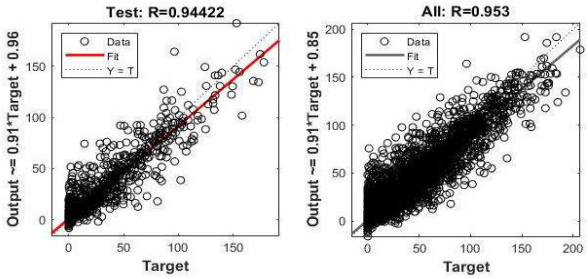

Fig. - Regression analysis

The above figure represents the regression obtained in the proposed system. The overall regression is around 0.95 which is very close to unity.

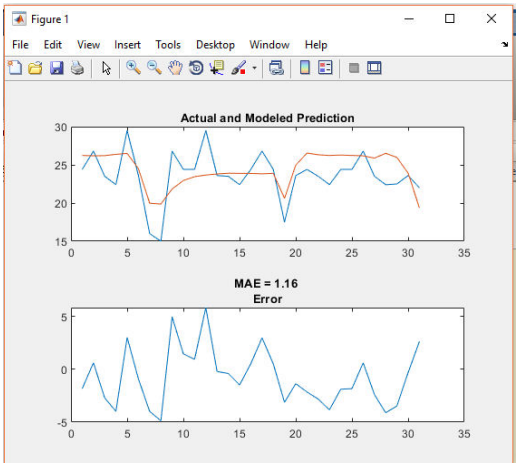

Fig. - Forecasted Values, Actual Values and MAPE w.r.t. time

The figure above depicts the accuracy with which the neural network is capable to predict future values. The relation which related the MAPE and accuracy is given by:

$$Accuracy(\%) = 100 - error\ (\%)$$

The MAPE is 1.16
Hence the accuracy is 98.84%.
A summary of results of the proposed system is tabulated below with the parameters and the obtained values used for training and testing.

Table - Performance parameters

Parameter	Value
Tool	MATLAB 2017a
Training Algorithm	Levenberg Marqardt
ANN Structure	2-20-20-20-1
Topology	Back Propagation
Performance Index	Mean Square Error (MSE)
Data division	70:30 for training:testing
Validation Checks	6
Iterations	11

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VI.CONCLUSION

The unsustainable nature of the fossils creates need for an alternative nature friendly energy sources. Henceforth renewable energy resources are the need of the world today. Proper and adequate renewable energy production and feasibility of usage is required to make it more widespread and prevalent. Solar power is one of the most reliable renewable sources of energy and holds strong potential for harnessing energy from it. If used in an effective method, it can aid in meeting high energy requirements in today high energy demanding economy. But one of the flipsides to the solar power energy is its uncertainty of the measure of energy that can be actually obtained. Among all the renewable resources of energy, like wind energy, geo thermal energy and tidal energy, the energy from solar power is subjected to the most fluctuations and variations as the solar irradiation keeps on changing and varying with time owing to various reasons related to natural phenomenon.

Hence artificial neural networks capable of time series predictions are gaining popularity for solar irradiation prediction. In this proposed work, physical parameters along with actual solar irradiation data are fed to a neural network to train it. The neural architecture incorporating back propagation has been used. The evaluation parameters for the neural network have been chosen as mean absolute percentage error, mean squared error and regression.

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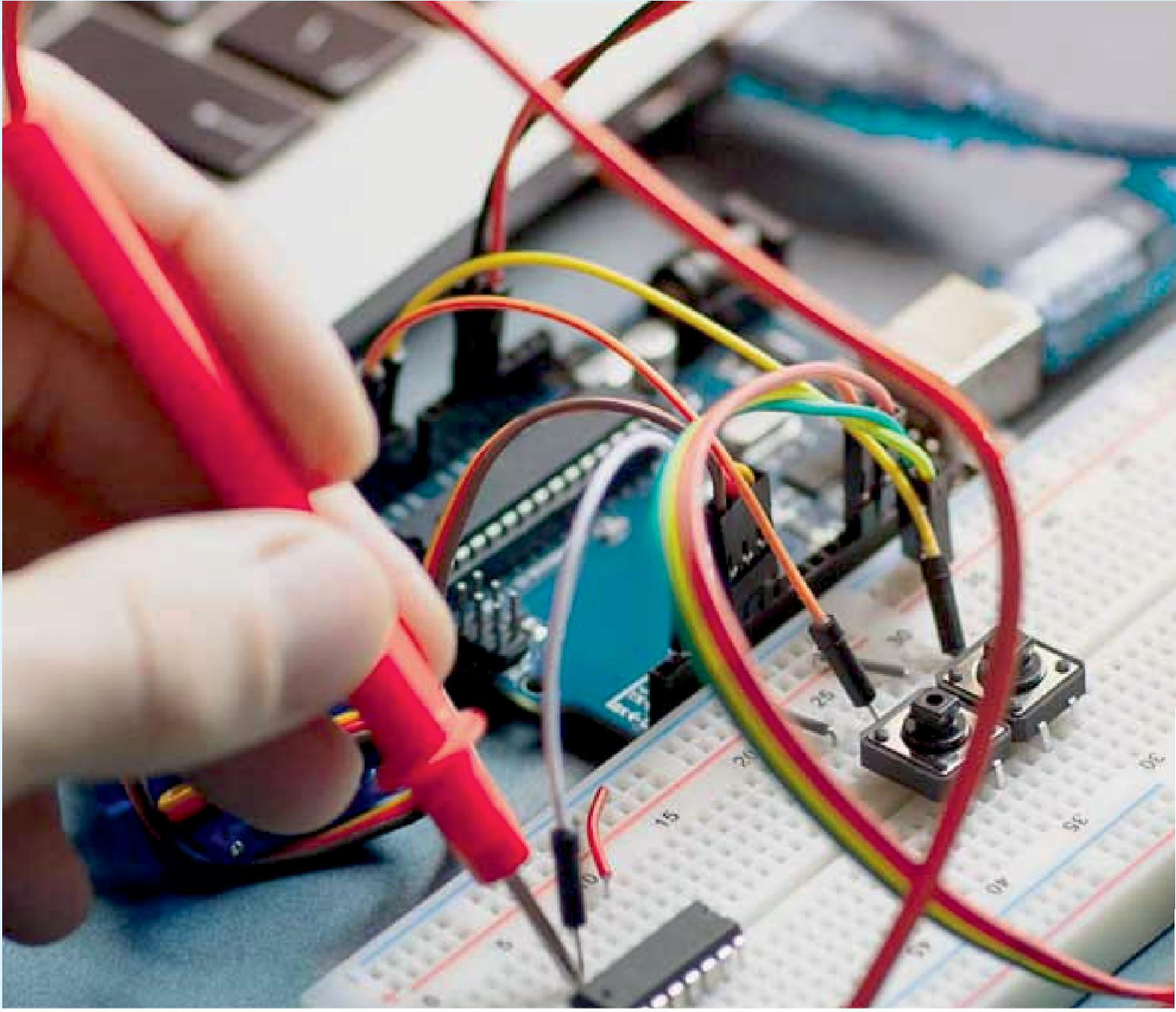

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