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Artificial Neural Network Based Efficiency Prediction and Its Impact on Dye Synthesized Solar Cell

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Abstract*: *Alongside numerous different parameters, the general proficiency of pv element relies upon temperature of cell, which, depends on different ecological variables. Natural conditions, for instance, speed of wind solar irradiance, and wind course and in particular, the temperature around the cell influences cells exhibition. Also the climate forecast and meteorology is an exceptionally perplexing and loose science, ongoing exploration exercises with counterfeit neural system (ANN) have indicated that it has ground-breaking design arrangement and example acknowledgment capacities and that can be utilized as a device to obtain a sensible precise expectation of climate designs. This paper focuses on an application of Artificial Neural Network (ANN) to estimate the efficiency of Dye Synthesized solar cell. During writing of this research paper, development last ten years has been considered. An Artificial Neural Network model based on Multilayer Perceptron concept has been developed and trained using Levenberg-Marquardt feed-forward algorithm for prediction. The model was tested and trained using ten years of efficiency data of Dye synthesized solar cell. The exactness of the model was determined on premise of Mean Square Error. The result shows that Neural Network can be used for efficiency prediction successfully

Keywords*: *ANN, Dye Synthesized Solar Cell, Efficiency Prediction

I. INTRODUCTION

Energy crisis or high demand of energy is one of the significant dangers looked by the present world. The hole market interest of power is one of the significant obstructions for monetary development here, particularly throughout the mid year, when the power authority is left with no choice however to have planned load-shedding of electricity[1] To beat the negative effects on the earth and different issues related with petroleum derivatives have constrained numerous nations to ask into and change to natural amicable choices that are inexhaustible to continue the expanding vitality request. Solar energy is outstanding amongst other sustainable power sources with least negative effects on the earth. [2] Inexhaustible advances are considered as spotless wellsprings of vitality and ideal utilization of these assets limit ecological effects produce least optional squanders and are supportable dependent on present and future financial and social cultural needs. Sun is the wellspring everything being equal. The essential types of solar energy are warmth and light. [3]

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II. EFFECT OF PARAMETERS ON EFFICIENCY OF SOLAR CELLS

The effectiveness is the most ordinarily utilized parameter while considering the presentation of one solar cell to another. The various parameters are responsible for the calculating the efficiency of solar cells. Such parameters are as Short Circuit Current (Jsc), Fill factor (FF), Open circuit voltage (Voc), was studied to optimize the conditions to check the efficiency of Dye Synthesized solar cell. It is found that with increasing temperature of Dye Synthesized Solar Cell, the short circuit current of the cell increases and open circuit voltage decreases.

The Jsc and Voc are the most extreme current and voltage parameter of solar cell. The fill factor, all the more normally known by its shortened form "FF", is a parameter which, related to Voc and Isc, decides the power from a solar cell. The FF is characterized as the proportion of the most extreme power from the solar cell to the result of Voc and Isc so that:

$$FF = \frac{PMP}{Voc\ X\ Jsc} \qquad [4]$$

Where,

FF : fill factor,
PMP : maximum power point
Voc: open-circuit voltage
Jsc : short-circuit current

The efficiency of a solar cell is resolved as the division of occurrence control which is changed over to power and is characterized as:

$$Pmax = VocJscFF$$

$$\eta = \frac{VocJscFF}{Pin}$$

Efficiency is characterized as the proportion of energy yield from the solar cell to include energy from the sun.

III. BASIC CONCEPTS OF NEURAL NETWORK

ANN is a system of basic handling neurons which can display complex worldwide behavior controlled by the association between preparing components and component parameters.

A. Features of ANN

• Can gain from cases and changes with circumstances dependent on its discoveries.
• Flexible enough to be changed in accordance with different info examples and adjust to a various exhibit of questions.
• Is fit for speaking to both straight and non direct connections

B. Features of Multilayer Perceptron Model

• It is a feed-forward artificial neural network model which ultimately maps sets of information onto a lot of proper yields.
• It is made of three layers one is Input layers, second is shrouded layers (hidden layer) and the third is yield layers (output layer).
• This model performs superior to single layer perceptron in instances of nonlinear capacity estimate, speculation and so forth.

C. Back-propagation Learning

• It is a strategy for learning effectively in a network called as multilayer feed-forward network.
• The mistake at the yield layer is determined by examination of genuine yield and the ideal incentive to refresh the loads of the yield and shrouded layers.
• Mainly, the loads of the network are arbitrarily instated.

IV. METHODOLOGY

A. Back-propagation algorithm

The back-propagation calculation comprises of the accompanying advances:
• First initialize the loads
• Repeat with comparing the determined yield and genuine yield
• Update the connecting loads
Until: Error < adequate farthest point

B. The technique of Data collection and processing

• Different information of parameters is gathered from a scope of sources.
• These information were utilized to train the model and picked for testing reason.
• Activation work picked: Sigmoid function
• Normalization recipe: (Actual Value - Minimum worth)/(Maximum Value - Minimum worth)

C. System modeling

Following parameters have been considered during the study
- Number of hidden layer neurons
- Training percentage (5% to 35%)
- Validation percentage (5% to 35%)
- Testing percentage (5% to 35%)
- Number of Iterations

Here, impact of performance network parameters is shown for efficiency. The same process is repeated for number of iterations. Here we get the best performance for the hidden neuron 20 shown as in following figure 1.

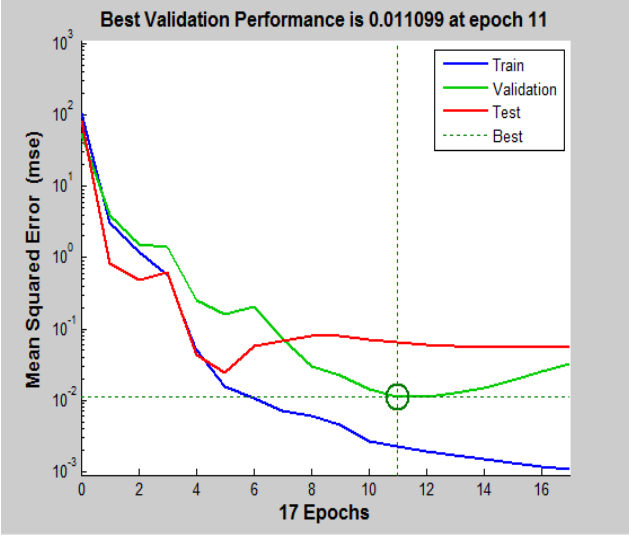

Fig. 1 Performance network for Dye Synthesized Solar cell for the hidden neuron 20

D. Effect of number of hidden layer neurons

Hidden nodes in the concealed layer that enable neural networks to distinguish the component, to catch the example in the information and to perform convoluted nonlinear mapping among information and yield factors. Our created program enables us to fluctuate the quantity of layers from 5 to 35 and we get the best outcomes for the hidden neurons 20. Following figure 2 shows the regression coefficient for the hidden neuron 20 which is approximately 1.

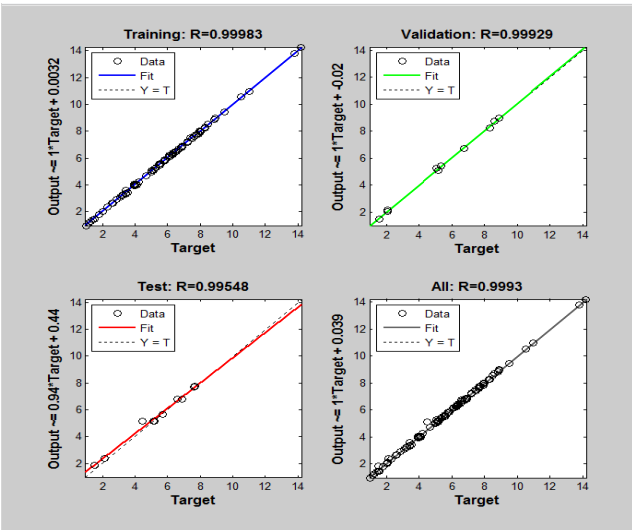

Fig. 2 Regression coefficient for Dye Synthesized Solar cell for the hidden neuron 20

V. PREDICTED OUTCOME

In the wake of choosing the ideal model along with balanced parameters, the Mean Square error has been anticipated during the testing period. The Neural network shown here is compared with predicted outcome.

Following table 1 shows the experimental and predicted results of Dye Synthesized Solar cell using Artificial Neural Network [5].

Figure 3 shows the predicted Mean square error for Dye Synthesized Solar cell using ANN. When Value of hidden neuron was '20' then average value was -0.003422499.

Table. 1 Experimental and predicted results of Dye Synthesized solar cell using ANN

Name of the Solar Cell	Input Values			Experimental Results	Predicted Results using ANN
DYE SYNTHESIZED solar cell [Material used: TiO_2]	J_{sc} (mA cm^{-2})	V_{oc} (mV)	FF	η (%)	η (%)
	700	13	63.5	5.85	5.90574
	730	14.08	66.35	6.87	6.863658
	638	20.07	52.8	6.8	6.911473
	627	23.65	53.3	7.95	7.944104
	624	27.32	51.6	8.84	8.844838
	753	10.28	69	5.34	5.355474
	850	10.9	69	6.4	6.393007
	590	29.66	39	6.75	6.747456
	650	22.25	42	6.14	6.107475
	580	15.08	51	4.47	4.457269

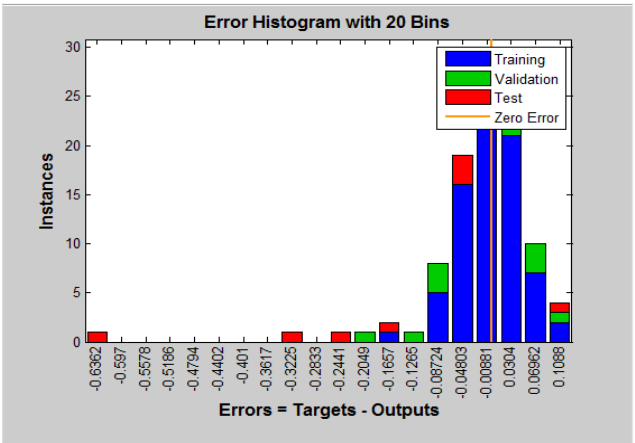

Fig. 3 Mean square error for Dye Synthesized Solar cell using ANN for the hidden neuron 20

VI. RESULT ANALYSIS

Table. 2 Result analysiss of Dye Synthesized solar cell using ANN

Name of the Solar Cell	Experimental Results	Predicted Results using ANN
DYE SYNTHESIZED solar cell [Material used: TiO_2]	η (%)	η (%)
	5.85	5.90574
	6.87	6.863658
	6.8	6.911473
	7.95	7.944104
	8.84	8.844838
	5.34	5.355474
	6.4	6.393007
	6.75	6.747456
	6.14	6.107475
	4.47	4.457269

As shown in Table 2; efficiency of Dye Synthesized solar cell when Jsc is 0.850, Voc is 10.9 and FF is 69, the efficiency calculated by the predicted model is 5.355474 which is approximately equivalent to the efficiency calculated by experiments in the laboratory. In the same way we have calculated the efficiency for different input values. For training the data set, a supervised learning method has been used, as this is the most ultimate method in the above scenario. To get the productivity of Dye Synthesized solar cell, 20 hidden layers have been applied because at 20 hidden neurons the proficiency is closer to the real outcomes. For an alternate number of neurons, it produces distinctive productivity which is a long way from real outcomes.

VII. CONCLUSION

This paper presents effectiveness prediction with great exactness in light of the fact that ANN is particularly helpful for expectation where the interrelationships between information are hard to determine however for which there are sufficient information or perceptions. For that ANN might be utilized as a direct expectation instrument utilizing the different information parameters than different strategies. For various neuron esteems we found diverse normal mistakes of Dye Synthesized solar cell. For the shrouded neuron 20 we got the successful outcome.

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