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Optimization of Grid Connected Hybrid Renewable Energy Source Using Adaptive Neurons Fuzzy Inference System

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ABSTRACT: Adaptive Neurons Fuzzy Inference System (ANFIS) Is Efficient Estimation Model Not Only Among Neurons Fuzzy Systems But Also Various Other Machine Learning Techniques. Despite Acceptance Among Researchers, ANFIS Suffer From Limitations That Halt Application In Problems With Large Inputs; Such As Curse Of Dimensionality And Computational Expense. Various Approaches Have Been Proposed In Literature To Overcome Such Shortcomings However There Exists A Considerable Room Of Improvement. This Project Report Approaches From Literature That Reduce Computation Complexity By Architectural Modifications As Well As Efficient Training Procedures. Moreover, As Potential Future Directions, This Project Also Proposes Conceptual Solution To The Limitations Highlighted

KEYWORDS: ANFIS, fuzzy logic, neural network, neuron-fuzzy, bigdata.

I. INTRODUCTION

According To Lofty Zane (Informally, The Fusilier Of Crisp Domain) In Human Cognition Almost All Classes Have Unshorn (Fuzzy) Boundaries [1]. Hence, Coupling, Embedding Or Meshing Fuzzy Ingredients Into Neural Networks With Bivalent Logic Will Enable Us To Comply With Zane's Statement. This Marriage Of Learning Capability Of Neural Network And Knowledge Representation Ability Of Fuzzy Logic Has Given Birth To Fuzzy Neural Networks. As A Result, The Drawback Of Neural Network Black Box Inability To Explain Decision (Lack Of Transparency), And Weakness Of Learning In Fuzzy Logic Have Been Conquered .According To Literature, Fuzzy Neural Networks Are Able To Approximate Any Plant With High Degree Of Accuracy; Be It Engineering, Medicine, Transportation, Or Business And Economics, Etc. [2]. This Success Has Led To Significantly Conspicuous Literature Comprising Of Improvements And Modifications [3], Applications [4], And Surveys Or Reviews [2] Of Fuzzy Neural Networks. As One Of The Prominent Neuron Fuzzy Systems, Adaptive Neuron Fuzzy Inference System (ANFIS), Introduced By Jang In 1993 [5], Has Gained Remarkable Attention From Researchers. Nevertheless, ANFIS Faces Major Limitations Such As Curse Of Dimensionality And Training Complexity Which Restrict Applications On Problems With Large Datasets. As [6] Rightly Pointed Out A Major Problem That It Is Again A Problem On Making[s] Corresponding Author's Email: Najib@Uthm.Edu.MyDecisions About Number, Type And Initial Values Of Membership Functions, Initial Rule-Base, And Input Space Clustering Or Partitioning Method. In This Study, Emphasis Is Placed On Basic Concepts And Architectural Aspects Of Antis. The Rest Of The Paper Is Organized As Follows: The Subsequent Section Explains Antis Architecture, Its Strengths And Limitations. Solutions To Limitations From Existing Literature Are Reported In Section 3, Whereas The Conceptual Solutions To The Shortcomings Are Proposed In Section 4. Finally, Section 5 Concludes The Study And Highlights Future Prospects In This Area Of Research

II. MODEL SYSTEM

In response to limitations identified previously, this paper proposes conceptual solutions that can act as potential future directions in research related to ANFIS performance improvement. Table 2 reveals that ample number of rules produces better accuracy of the ANFIS output. In this connection, grid partitioning is useful method that generates maximum number of rules. That said, it also increases computational cost as consequent part of rules contains most of the parameters. Therefore, fourth layer

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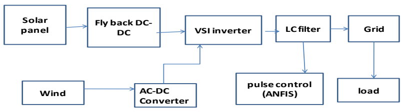
which holds linear coefficients shares most of the computational cost of training algorithm. The removal of fourth layer may contribute to reduction of computation hence ANFIS architecture can be reduced to four layers. Furthermore, instead of gradient based learning mechanism in typical ANFIS, met heuristic algorithms can be employed to train all the parameters. heuristic paradigm. Additional to layer reduction approach discussed before, rules can also be reduced by selecting potential rules for producing the most suitable rules set to address the trade-off of lessening computational cost, increasing accuracy and also enhancing interpretability. This approach, may apply threshold for error tolerance on fourth layer to filter the rules that best meet the error criteria. Rule minimization by selecting suitable rule-set for producing powerful rule- base, that contains only the rules that contribute the most in accuracy of the mode thus can be achieved



Block diagram

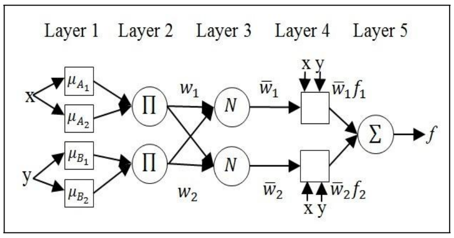


Fig. 2. ANFIS architecture

III. ADAPTIVE NEURO FUZZY INFERENCE SYSTEM (ANFIS)

In machine learning area, FNN also referred to as fuzzy inference system is an effective hybrid of fuzzy logic and neural network which has achieved significant success in approximation and control models. Unlike ANN, FNN maps inputs through input membership functions to the desired output(s) via output membership functions, and this mapping generates rule-base in the course of learning. These rules in FNN are directly mapped into the neural structure of the network. The accuracy of rules depends on appropriateness of type (Fig. 1) and parameters of membership functions. ANFIS is based on Takagi Segno Kang Model (TSK), or simply Segno fuzzy model, proposed by [7] where a rule R_k can be represented as:

R_k : IFμ_{A} (x)ANDμ_{B} (y)THE N $f = p_k x + q_k y + r_k$ (1)

where k is the number of rules, A_i and B_i are n fuzzy membership functions of any shape i.e., Gaussian, triangular, trapezoidal etc., denoted by μ in the antecedent part of the rule R_k , and p_k, q_k, r_k are the linear parameters of consequent part of the k t h rule. The parameters of membership functions (an-decedent or premise parameters) and consequent part of the rule (consequent parameters) are tuned during the training process. ANFIS five -layers architecture comprises of two types of nodes: fixed and adaptable (Fig. 2). The nodes in membership function layer and consequent layer are tunable, the rest of the nodes are fixed. In Layer 1, the node i is a membership function i.e., triangle, trapezoidal, or GAUSSIAN, etc. For example, if μ_{A1}, μ_{A2} and μ_{B1} , μ_{B2} are the membership Functions of GAUSSIAN shape with two parameters center (c) and width (σ).

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IV. TEST SYSTEM MODEL

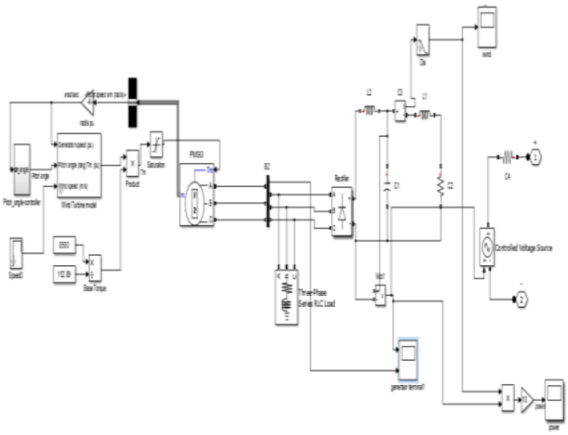
WIND ENERGY

Wind is caused by the uneven heating of the atmosphere by the sun, variations in the earth's surface, and rotation of the earth. Mountains, bodies of water, and vegetation all influence wind flow patterns.

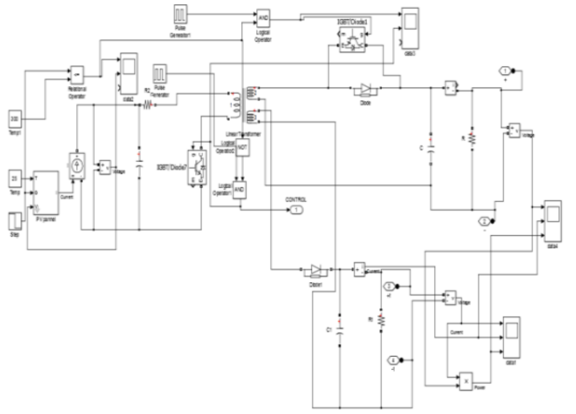
PHOTOVOLTAIC CELL:

Photovoltaic cell is the basic unit of the system where the photovoltaic effect is utilized to produce electricity from light energy. Silicon is the most widely used semiconductor material for constructing the photovoltaic cell. While light ray strikes on any materials some portion of the light is reflected, some portion is transmitted through the materials and rest is absorbed by the materials.The same thing happens when light falls on a silicon crystal. If the intensity of incident light is high enough, sufficient numbers of photons are absorbed by the crystal and these photons, in turn, excite some of the electrons of covalent bonds. These excited electrons then get sufficient energy to migrate from valence band to conduction band. As the energy level of these electrons is in the conduction band, they leave from the covalent bond leaving a hole in the bond behind each removed electron. These are called free electrons move randomly inside the crystal structure of the silicon. These free electrons and holes have a vital role in creating electricity in **photovoltaic cell**. These electrons and holes are hence called **light-generated electrons and holes** respectively. These light generated electrons and holes cannot produce electricity in the silicon crystal alone. There should be some additional mechanism to do that.There is always a potential barrier between n-type and p-type material. This potential barrier is essential for working of a photovoltaic or solar cell. While n-type semiconductor and p-type semiconductor contact each other, the free electrons near to the contact surface of n-type semiconductor get plenty of adjacent holes of p-type material. Hence free electrons in n-type semiconductor near to its contact surface jump to the adjacent holes of p-type material to recombine. Not only free electrons, but valence electrons of n-type material near the contact surface also come out from the covalent bond and recombine with more nearby holes in the p-type semiconductor. As the covalent bonds are broken, there will be a number of holes created in the n-type material near the contact surface. Hence, near contact zone, the holes in the p-type materials disappear due to recombination on the other hand holes appear in the n-type material near same contact zone. This is as such equivalent to the migration of holes from p-type to the n-type semiconductor. So as soon as one n-type semiconductor and one p-type semiconductor come into contact the electrons from n-type will transfer to p-type and holes from p-type will transfer to n-type. The process is very fast but does not continue forever. After some instant, there will be a layer of negative charge (excess electrons) in the p-type semiconductor adjacent to the contact along the contact surface. Similarly, there will be a layer of positive charge (positive ions) in the n-type semiconductor adjacent to contact along the contact surface. As such light generated holes are shifted to the p-region where they are trapped because once they come to the p-region cannot be able to come back to n-type region due to the repulsion of potential barrier. As the negative charge (light generated electrons) is trapped in one side and positive charge (light generated holes) is trapped in opposite side of a cell, there will be a potential difference between these two sides of the cell. This potential difference is typically 0.5 V. This is how a **photovoltaic cells** or **solar cells** produce potential difference

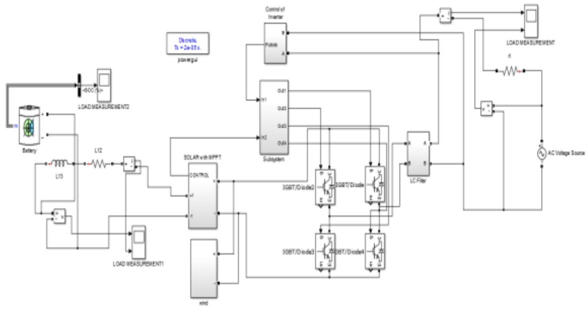
WIND ENERGY CIRCUIT DIAGRAM



SOLAR SIMULATION DIAGRAM

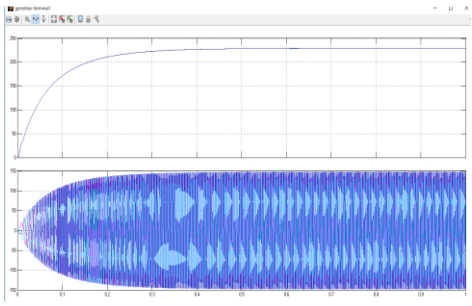


OVERALL DIAGRAM

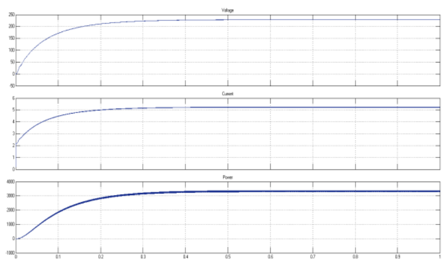


V. SIMULATION ANALYSIS AND DISCUSSION

WIND OUTPUT WAVE FORM



SOLARPANELOUTPUTWAVEFORM



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VI. CONCLUTION

In this research work, an overview of ANFIS architecture has been presented in order to highlight the computational complexity of the network. The number of parameters and rules play crucial part in increasing the computational cost of ANFIS based models. Moreover, different limitations such as curse of dimension-ability, interpretability of rules, and parameter training are the major hurdled that need to be overcome for the implementation in problems with larger number of inputs .this is the reason, ANFIS is often integrated with additional techniques for input selection, rule reduction and parameter tuning, which again increases the complexity of the designed model. Various structural and parameters optimization techniques have been proposed in literature; however, there is enough room of improvement in ANFIS architecture so that applications in larger problems can be achieved easily. To overcome these issues, conceptual solution has been proposed in this research, which reflects interesting future research directions.

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