Design And Analysis Of New Technique For The Mppt Control Of Stand Alone Hybrid System

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***Abstract*: A hybrid system is proposed in this paper. For fast and stable response an intelligent controller is developed. In this paper a hybrid system consist of wind system, solar system and a diesel engine.For the solar system Radial based function network is used to simulate the system.For wind energy system Elman neural network is used.For the better performance of MPPT a neuro fuzzy controller is used. And also compare the response of hyrid system. The PV-wind hybrid system returns the lowest unit cost values to maintain the same level as compared to standalone solar and wind systems. For all load demands the levelised energy cost for PV-wind hybrid system is always lower than that of standalone solar PV or wind system. MATLAB/Simulink is used to simulate the system.**

***Index Terms*—Diesel engine, improved Elman neural network (ENN),maximum power point tracking (MPPT), photovoltaic (PV) power system, neuro-fuzzy controller), wind power system,neural network**

1 INTRODUCTION

Renewable energy sources also called non-conventional energy, are sources that are continuously replenished by natural processes**.** For example, solar energy, wind energy, bio-energy - bio-fuels grown sustain ably), hydropower etc., are some of the examples of renewable energy sources . At present, standalone solar photovoltaic and wind systems have been promoted around the globe on a comparatively larger scale . These independent systems cannot provide continuous source of energy, as they are seasonal.. The standalone wind system cannot satisfy constant load demands due to significant fluctuations in the magnitude of wind speeds from hour to hour throughout the year. Therefore, energy storage systems will be required for each of these systems in order to satisfy the power demands. Usually storage system is expensive and the size has to be reduced to a minimum possible for the renewable energy system to be cost effective. Hybrid power systems can be used to reduce energy storage requirements.

Topologies of the power electronic converter for maximum power point tracking (MPPT) [6] and voltage conversion are studied in this paper. The maximum power point of photovoltaic (PV) array is variational, so a search algorithm is needed according to the current–voltage (*I–V*) and power–voltage (*P–V*) characteristics of the solar cell. The perturbation and observation (P&O) MPPT algorithm is commonly used, due to its ease of implementation. It is based on the observation that if the operating voltage of the PV array is perturbed in a given direction and the power drawn from the PV array increases, which means that the operating point is moving toward the MPP, so the operating voltage must be further perturbed in the same direction. By using the P&O method, impedance matching is conducted between a boost converter and PV array in order to realize the MPPT function.

Novel methods are developed with higher accuracy but complex process, such as the optimum gradient method, fuzzy logic control, and neural networks (NN). These technique could also be costly, difficult to implement, and may not be stable enough .Radial basis function network (RBFN) has a faster convergence property than common multiplayer-perception NN, but with a simpler network structure. RBFN also has a similar feature as the fuzzy-logic system.

A small wind generation system with NN for wind-speed estimation and PI control for maximum wind-power extraction. Neural network is an abstract simulation of real nervous system and it used in many applications in engineering.ANN are massively interconnected network parallel of simple elements usually adaptive.The control algorithm is developed to use the artificial NN for detecting the optimal operating point under different operating conditions, then the control action gives the driving signals to the MPPT. The input signals to the NN are the solar radiation and the module temperature, whereas the output signal is the identified maximum power. The controller moves the operating power of the PV system to its maximum power by shifting the PV terminal voltage to its identified optimal value.

The advantages of small wind generator are small volume, easy installment, and little noise compared with other renewable energy sources. To increase the applicable wind power, the maximum power point searching and tracking is the major concern. Many MPPT studies has been proposed, such as, perturb and observe method, three-point-weighting comparison algorithm, and variable speed wind turbine power method, etc. The results demonstrated that the wind energy system is a nonlinear form, so it is difficult to establish the linear control method. The artificial neural network (ANN) is proposed to solve the nonlinear control problem.

A. THE PV MODULE

The PV systems are rapidly expanding and have increasing roles in electric power technologies, providing more secure power sources and pollution free electric supplies. Since the PV electricity is expensive compared to the electricity from the utility grid, theuser wants to use all the available output power. Therefore, the PV systems should be designed to operate at their maximum output power for any temperature and solar radiation level. For any PV system, the output power can be increased by two options; (a) increasing the incident solar radiation on the system, (b) tracking the maximum power point of the PV system. Option (a) requires using a sun tracker to track the sun position, to increase the solar radiation received by the PV system.PV system collect solar energy by different solar tracking systems .The PV systems should be designed to operate at their maximum output power for any temperature and solar radiation level. Solar energy is the most readily available and free source of energy since prehistoric times. It is estimated that solar energy equivalent to over 15,000 times the world's annual commercial energy consumption reaches the earth every year.

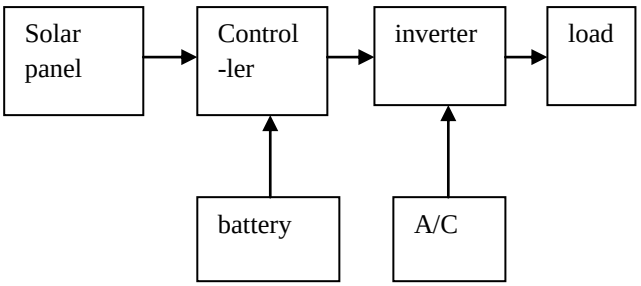


Fig 1 pv system

B.WIND ENERGY SYSTEM

Wind Power is energy extracted from the wind, passing through a machine known as the windmill. Electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives a generator to produce electricity. The windmill in this case is usually called a wind turbine. This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical power. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system (WECS).

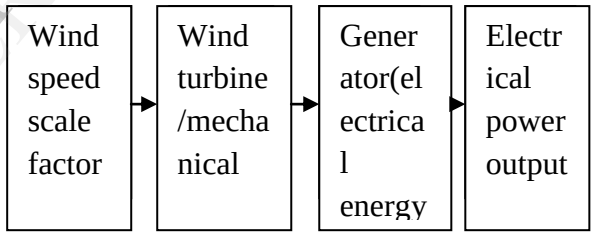


Fig 2 wind energy conversion system

Various mathematical models have been developed to assist in the predictions of the output power production of wind turbine generators (WTG)

II HYBRID SYSTEM

One of the primary needs for socio-economic development in any nation in the world is the provision of reliable electricity supply systems. This work is a development of an indigenous technology hybrid Solar -Wind Power system that harnesses the renewable energies in Sun and Wind to generate electricity. Here, electric DC energies produced from photovoltaic and wind turbine systems are transported to a DC disconnect energy Mix controller. The controller is bidirectional connected to a DC-AC float charging-inverter system that provides charging current to a heavy duty storage bank of Battery and at the same time produces inverted AC power to AC loads.

Hybrid power system can be used to reduce energy storage requirements. The influence of the Deficiency of Power Supply Probability (DPSP), Relative Excess Power Generated (REPG), Energy to Load Ratio (ELR), fraction of PV and wind energy, and coverage of PV and wind energy against the system size and performance were analyzed. The technical feasibility of PV-wind hybrid system in given range of load demand was evaluated. The methodology of Life Cycle Cost (LCC) for economic evaluation of stand-alone photovoltaic system, stand-alone wind system and PV-wind hybrid system have been developed and simulated using the model. The comparative cost analysis of grid line extension energy source with PV-wind hybrid system was studied in detail. The optimum combination of solar PV-wind hybrid system lies between 0.70 and 0.75 of solar energy to load ratio and the corresponding LCC is minimum.

The PV-wind hybrid system returns the lowest unit cost values to maintain the same level of DPSP as compared to standalone solar and wind systems. For all load demands the levelised energy cost for PV-wind hybrid system is always lower than that of standalone solar PV or wind system. The PV-wind hybrid option is techno-economically viable for rural electrification.

At present, standalone solar photovoltaic and wind systems have been promoted around the globe on a comparatively larger scale [7].. For example, standalone solar photovoltaic energy system cannot provide reliable power during non-sunny days. The standalone wind system cannot satisfy constant load demands due to significant fluctuations in the magnitude of wind speeds from hour to hour throughout the year. Therefore, energy storage systems will be required for each of these systems in order to satisfy the power demands. Usually storage system is expensive and the size has to be reduced to a minimum possible for the renewable energy system to be cost effective. Hybrid power systems can be used to reduce energy storage requirements.

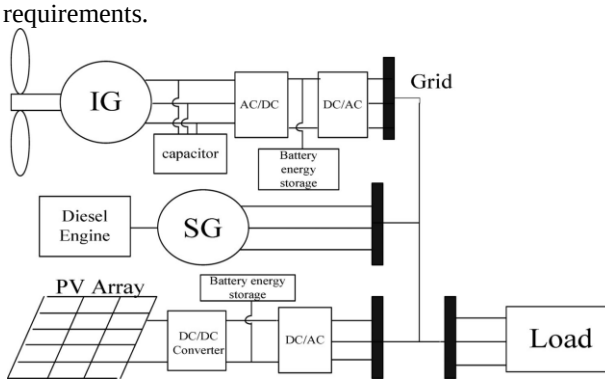


Fig 3 hybrid system

The proposed solar and diesel–wind hybrid system is shown
in Fig. 1. Dynamic models of the main components were developed consisting of
1) wind energy conversion system (WECS);
2) diesel generator system;
3) PV generation system;
4) battery energy storage system (BESS

III MPPT CONTROL ALGORITHM OF THE PV SYSTEM

With the cost of solar cell, it is necessary to implement MPPT to have the voltage operating close to the maximum power point under the changing environment. The proposed PV system is composed of a array of 4 × 4 panels, a dc/dc converter, battery storage, a dc/ac inverter, and a control algorithm, generally performed by a microcontroller to track the maximum power continuously. MPPT is also used to provide a constant voltage to the required load. This system is developed by combining the models of established solar module and DC-*DC buck-boost* converter with the algorithms of

a) Perturbation and observation (P&O)
b) Incremental conductance (INC) and
c) Hill climbing (HC),

respectively. According to the comparisons of the simulation results, it can be observed that the photovoltaic simulation system can track the maximum power accurately using the three MPPT algorithms discussed in this paper. P&Q MPPT algorithm possesses fast dynamic response and well regulated PV output voltage than hill climbing algorithm. Since the deterministic process of INC algorithm is more complicatedthan the other two algorithms, therefore, the simulation time spent by INC algorithm is also a little longer than the other two algorithms

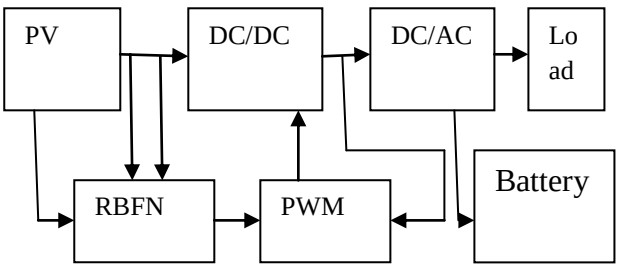


Fig 4 mppt controller using RBFN

A) RBFN CONTROLLER DESIGN

A three-layer RBFN NN with a boost converter shown in Fig. is adopted to implement the controller where the control law *V*MPPT is generated.
Basic Nodes Operation:

Layer 1: Input Layer

The nodes in this layer are used to directly transmit the numerical inputs to the next layer.

Layer 2: Hidden Layer

Every node performs a Gaussian function. The Gaussian function, a particular example of radial basic functions, is used here as a membership function

Layer *3:* Output Layer

The single node *k* in this layer is denoted by Σ, which computes the overall output as the summation of all incoming inputs

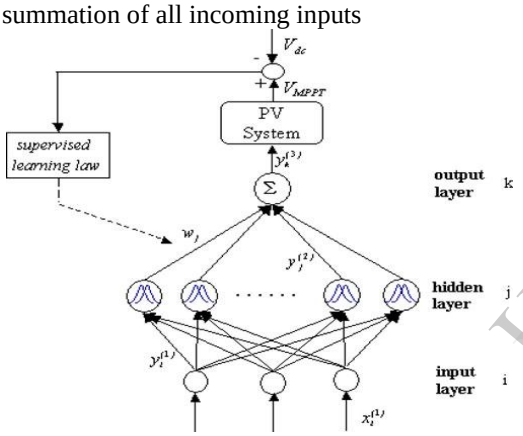


Fig 5 Radial basis function

RBFN are artificial neural networks for application to problems of supervised learning:

- Regression
- Classification
- Time series prediction.

Supervised Learning and Training Process: Once the RBFN has been initialized, a supervised learning law of gradient descent is used to train this system

IV MPPT CONTROL ALGORITHM OF THE WIND ENERGY SYSTEM

A)WIND ENERGY CONTROLLER DESIGN

The wind power generation system studied in this paper composed of an induction generator, a current control PWM ac/dc converter, a field-orientation mechanism including the coordinate translator, a current controlled dc/ac inverter, and the MPPT controller, where the PI and ENN were studied in this paper. The dc-bus voltage is regulated at a constant value so the real power from the wind turbine can pass to the grid.

Neurons sensitive to the history of input data, self-connections of the context nodes and output feedback node are added. So, the proposed ENN combines the ability of dealing with nonlinear problems, can effectively improve the convergence precision and reduce learning time.

Once the ENN has been initialized, a supervised learning is used to train this system based on gradient descent. The derivation is the same as that of the back-propagation algorithm.It is employed to adjust $W_{jo,}W_{rj},W_{rj}$ of the ENN by using training parameters. By recursive application of the chain rule, the error term for each layer is calculated, and updated. The purpose of supervised learning is to minimize the error function *E* expressed as

$$E=1/2(P_{OUT}-P_{REF})^2=1/2(e)^2$$

P_{OUT}=Actual power
P_{REF}=Reference power
e=Tracking response

V FUZZY CONTROLLERS

Solar photovoltaic (PV) electrification is an important renewable energy source. The electric which is converted directly from solar irradiation via PV panel is not steady due to different solar intensity. To maximize the PV panel output power, perturb and observe (P&O) maximum power point tracking (MPPT) has been implemented into PV system. Through a buck-boost DC-DC converter, MPPT is able to vary the PV operating voltage and search for the maximum power that the PV panel and wind system can produce. Based on the input change of power and input change of power with respect to change of voltage, fuzzy can determine the size of perturbed voltage and facilitate in maximum power tracking faster and minimize the voltage variation after the maximum power point has been identified.

DIFFERENT PROCESSING STEPS:

1.PREPROCESSING
2.FUZZIFICATION
3.DEFUZZIFICATION
4.POSTPROCESSING
5.MACHINE INTEFERENCE ENGINE

VI CONSTRUCTION OF THE FUZZY MPPT

For the experimental investigation of the fuzzy MPPT technique, a microprocessor-based tracker with the following capabilities was constructed and used:

a) Implementing the fuzzy MPPT technique.
b) Continual control of buck DC/DC converter according to the fuzzy tracking method.
c) On-line measurements of solar panel voltage and current as well as computing the fuzzy processor input parameters .

VII HYBRID NEURO-FUZZY CONTROLLERS

Fuzzy systems and neural networks have attracted the interest of researchers in various scientific and engineering areas. The number and variety of applications of fuzzy logic and neural networks have been increasing, ranging from consumer products and industrial process control to medical instrumentation information systems and decision analysis . The main idea of fuzzy logic control (FLC) is to build a model of a human control expert who is capable of controlling the plant without thinking in terms of a mathematical model. The control expert specifies his control actions in the form of linguistic rules. These control rules are trans2 lated into the framework of fuzzy set theory providing a calculus which can simulate the behaviour of the control expert. The specification of good linguistic rules depends on the knowledge of the control expert, but the translation of these rules into fuzzy set theory framework is not formalized and arbitrary choices concerning, for example, the shape of membership functions have to be made. The quality of fuzzy logic controller can be drastically affected by the choice of membership functions. Thus, methods for tuning fuzzy logic controllers are necessary

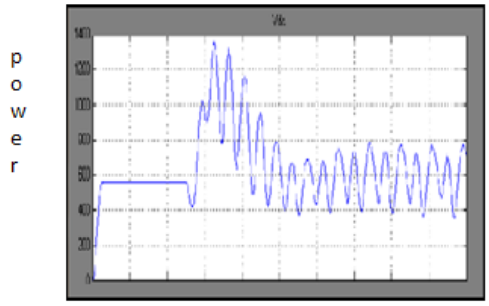
Neural networks offer the possibility of solving the problem of tuning. Although a neural network is able to learn from the given data, the trained neural network is generally understood as a black box. Neither it is possible to extract structural information from the trained neural network nor can we integrate special information into the neural network in order to simplify the learning procedure. On the other hand, a fuzzy logic controller is designed to work with the structured knowledge in the form of rules and nearly everything in the fuzzy system remains highly transparent and easily interpretable. However, there exists no formal framework for the choice of various design parameters and optimization of these parameters generally is done by trial and error

VIII HARMONIC ANALYSIS

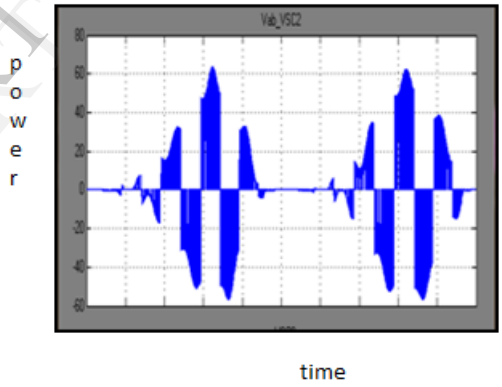
The harmonic currents pose one big challenge to the measurement of power quality. It requires great accuracy, even for higher frequencies, since themeasurement refers to interharmonics that are in the range of 0.1% of the rated current.

IX SIMULATION RESULTS

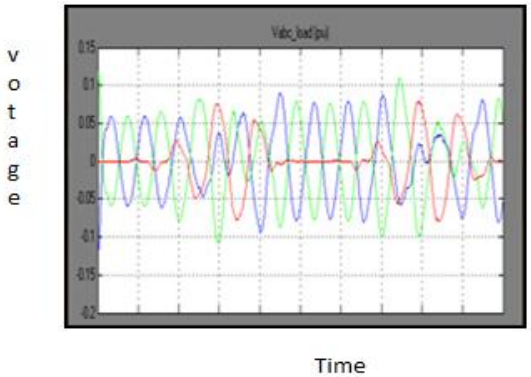
MPP TRACKING RESPONSE OF PV SYSTEM UNDER LOAD CHANGE



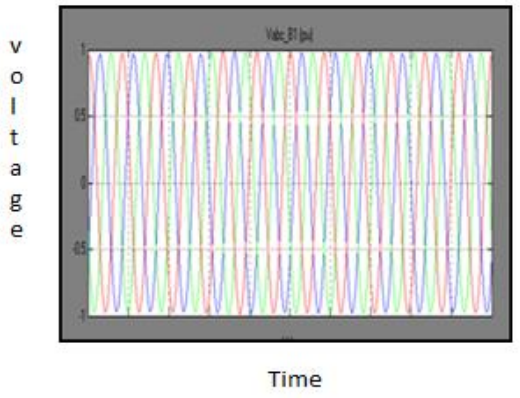
MPP TRACKING RESPONSE OF WIND SYSTEM UNDER LOAD CHANGE



LOAD VOLTAGE UNDER SUDDERN ENVIRONMENT



GRID VOLTAGE



IX CONCLUSION

In this paper, a solar and diesel–wind hybrid generation system was proposed and implemented. This stand-alone hybrid generation system can effectively extract the maximum power from the wind and solar energy sources. From the case studies, it shows that voltage and power can be well controlled in the hybrid system under a changing environment. An efficient power sharing technique among energy sources are successfully demonstrated with more efficiency, a better transient and more stability, even under disturbance.

For better performance instead of -neural network we proposed a hybrid neuro-fuzzy network. The simulation model of the hybrid system was developed,using MATLAB/Simulink.

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