

DESIGN AND IMPLEMENTATION OF HYBRID WIND-SOLAR ENERGY SYSTEM FOR PUMPING WATER BASED ON ANN CONTROLLER

I. ABSTRACT

Solar energy and wind energy are being used more and more as a renewable source by various countries for different purposes. These energies offer many advantages and have a unique limitation due to the instability of energy. The aim of this proposal is to command and synchronize the power flow of one hybrid system using two sources of energy (solar and wind). The first contribution of the present work is represented by the utilization of an Artificial Neural Network controller to command the maximum power point at fixed atmospheric conditions. The second contribution is represented by the optimization of the system respecting real-time constraints in order to increase the generating system performance. For this, the simulation and hardware implementation of the proposed algorithm are accomplished using MATLAB/SIMULINK and a Xilinx System Generator. The simulation results confirm that the considered system presents acceptable execution real time performance and precision. The proposed designed model and its control strategy give the opportunity to optimize the hybrid power system performance, which is utilized in rural pumping applications.

II. PROBLEM STATEMENT

Water is absolutely necessary for life and the need of water increases more and more with the rise in world population. Pumping water is very important to clean water for drinking and irrigate agricultural fields. The expensive installation of the grid to pump water in rural villages is also considered a big problem in many developing countries. Furthermore, transporting fuel, needed for water pumping), in rural villages can be difficult, unsafe and with limited quantity. The most attractive energy used in rural areas to pump water is the renewable energy, such as Photovoltaic (PV) panels and wind machines. Thanks to the importance of these renewable energies, the combination of these two intermittent sources can guarantee the stability and continuity of the energy production. Regardless of day or night, a wind energy resource is always there. The solar energy resource is present only in daytime, but because solar energy is continuous and stable, it can make up for the intermittent characteristics and the discontinuity of wind energy in daytime.

Current research and development efforts are required to ameliorate the efficiency and performance of PV panels as well as wind turbines, which are one of the most studied subjects of modern modular technologies. According to the irregular character of solar and wind energies, Maximum Power Point Tracking (MPPT) algorithms are utilized for the extraction of the maximum power in order to get the optimum performance of a hybrid system. The MPPT algorithms are classified into two principal categories. One category utilizes classic methods, like hill-climbing, incremental conductance and Perturbation and Observation (P&O). Another category uses intelligent methods, like Artificial Neural Networks (ANNs), fuzzy logic or a combination of both methods. Recently, ANNs have been used to solve very complex problems in many application fields. The specific solution for various non-linear and complex systems can be determined using the function and results of ANNs.

III. AIM

The main contribution of this article is to implement a controller, on a Field-Programmable Gate Array (FPGA), named ANN MPPT. The power management controller is used to command, supervise and synchronize, in real time, the power output of a system consisting of two energy sources (wind and solar).

IV. OBJECTIVE

The first objective of the present work is to develop intelligent ANN controllers for the proposed hybrid system and to control the duty cycle (d) and the proportional-integral of solar energy and wind turbine, respectively. For the wind system, in order to extract the Maximum Power Point (MPP), the boost converter is controlled to check, for every wind speed, the optimum rotor speed. In the same way, for the solar system, the PV-array MPP is variational. Indeed, the boost converter is adjusted to determine the optimum Pulse Width Modulation (PWM) in accordance with the current-voltage characteristics. The solar and wind energy systems are designed using MATLAB/SIMULINK

The second objective of this paper is to implement, on a FPGA, the ANN MPPT controller proposed in the hybrid wind-solar conversion system using a Xilinx System Generator (XSG) a plug-in to SIMULINK which actually allows designing and simulating a system through the use of MATLAB/SIMULINK and Xilinx library. XSG handles most routing and placement timing. Furthermore, FPGA offers many advantages compared with a sequential machine microcontroller. It achieves the current operation where the instructions are executed continuously and simultaneously. FPGA is suitable as a rapid implementation controller which can be programmed to do several types of digital functions.

V. PROPOSED SYSTEM

The global scheme of the wind-solar system, presented in this article, is shown and detailed in Figure 1. Its principal blocks are: one Permanent Magnet Synchronous Generator (PMSG), a continuous DC-DC bus, one wind turbine, a PV generator, boost converters and ANN controllers. For the management of the energy produced, we use a DC-DC converter for each energy source directly connected to the batteries in order to maintain the values of the voltage. In addition, we use control loops in the wind subsystem to facilitate the neural control of the optimal speed.

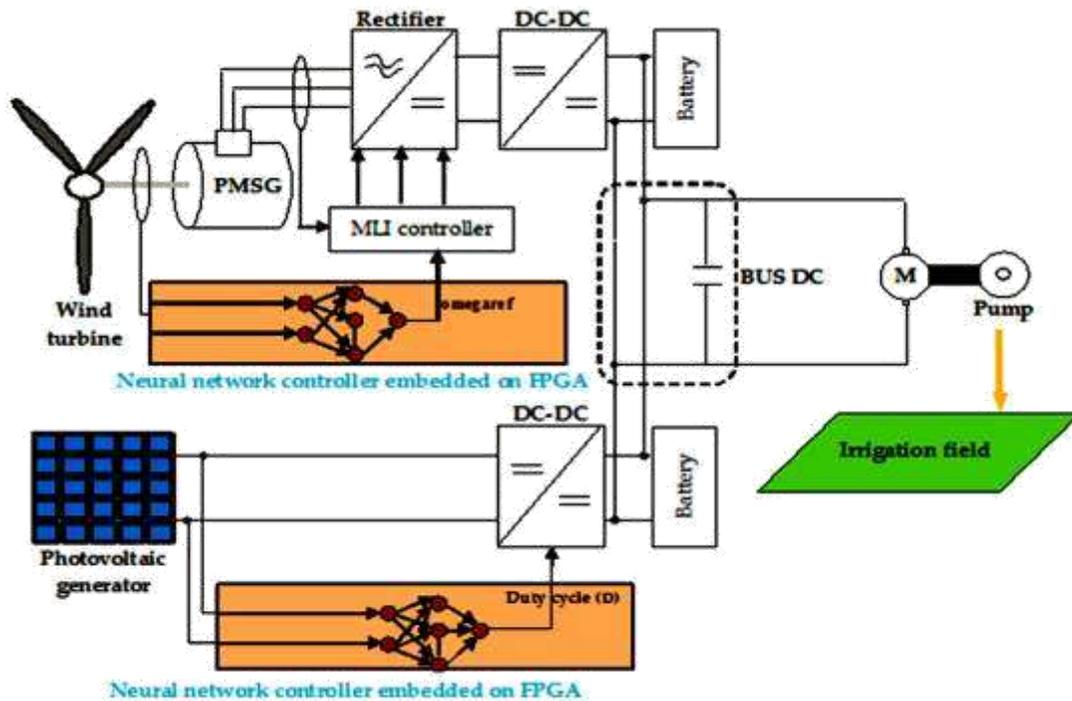


Figure 1: Global scheme of hybrid pumping system

VI. CONCLUSION

The research mainly concentrated on the usage of the recent technology on our real time applications. So the renewable technology has been chosen as the energy source which is non-depleting in nature and non-polluting as well. This technique utilizes the energy as much as possible on the environment for a remote environment where the power demands are there and less reachable. This work can be slowly expanded to the next level to meet all the needs. Even though it is little expensive we can afford with the subsidy provided by the Government agencies.

VII. LITERATURE REVIEW

- 1. “Hardware Implementation of Hybrid Wind-Solar Energy System for Pumping Water Based on Artificial Neural Network Controller”, Studies in Informatics and Control, Ons ZARRAD1, Mohamed Ali HAJJAJI, Mohamed Nejib MANSOURI (2019).**

This study revealed various methods of MPPT techniques which can be deployed at the wind solar hybrid system and it gave the knowledge of the new technique involved in the MPPT algorithm which is more effective when compared with the other techniques. The Artificial Neural network technique has feed forward and feed backward networks, out of which MLP (Multilayer Perceptron) method has been chosen. The other objective of this study is the design of the wind solar hybrid system, the MPPT, PWM, the battery bank has been designed using Xilinx System Generator (XSG) at Matlab/Simulink tool.

- 2. “Modeling and Simulation of Solar PV and DFIG Based Wind Hybrid System”, Smart Grid Technologies, Rajesh Ka, A.D Kulkarni, T.Ananthapadmanabha(2015).**

This proceeding gave the detailed picture of designing the Wind and Solar hybrid system using Matlab / Simulink tool. As well as each sub systems have been designed individually with simulation. This gave the concept and mathematical way of designing the circuit in the matrix laboratory.