Performance improvement of a hybrid wind-solar hybrid simulated with a PI Controller

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Abstract: The charge controller output is connected to provides continuous power to the grid system. An appropriate control strategy should be used to provide energy quality improvement performance to the inverter. Traditional PI controllers can be replaced by a fuzzy controller for better control, improving system performance. In this research, a hybrid wind-solar hybrid system with performance-enhancing features is simulated with a PI controller, so the results are compared by replacing PI with the fuzzy controllers. This integration of hybrid renewable energy systems and energy systems is analyzed and observed to see how much the function of AC grid systems is reduced in order to save energy and promote the use of green energy in implementing this simple hybrid system. The proposed system simulation studies are performed using the Matlab/Simulink platform and the results are evaluated based on the improvement of the DC voltage and power supply of the electricity grid.

Keywords: Renewable Fuel Cell, PSO-MPPT Charge Controller, DC/DC Converter, Fuzzy Controlled Inverter, Grid System.

1. INTRODUCTION

Energy incorporates a very important role for the development of a nation and it's to be preserved in a very most effective manner. Energy is that the ultimate issue accountable for each industrial and agricultural development. The new technologies that are developed to provide energy within the most environmental friendly manner and conservation of energy resources in most economical means has equal importance. The utilization of renewable energy technology to satisfy the energy demands has been steady increasing for the past few years. Import of petroleum products constitutes a serious drain on our foreign exchange reserve. Renewable energy sources are considered to be the higher choice to meet these challenges. The necessary drawbacks related to renewable energy systems are their inability to ensure reliability and their intermittent nature. A serious challenge of grid integration an increasing number of renewable-energy-based distributed generators is featured whereas making certain stability, voltage regulation, and power quality

1.1 SOLAR POWER CONVERSION AND MPPT

The solar energy generation systems have attracted in depth attention in many application areas like agricultural, residential, and even industrial sites. Moreover, the sensations associated with greenhouse emissions and carbon footprints are key factors to promote the use of solar energy systems. Nowadays, the installation costs are reduced and overall potency of a PV system is increased comparing to a few decades ago.

The solar panel may be a combination of PV modules serial and parallel to get the desired power in various voltage and current ratings. The power conversion stage consists of dc power interface and its ac conversion pairs. The dc-dc converters are wont to stabilize the intermittent characteristic of solar array that's significantly depended to solar irradiation and ambient temperature [6]. the ability conversion structure are often in single-stage or double-stage interface wherever the single-stage includes simply a dc-ac inverter whereas the double-stage consists of dc-dc converter and dc-ac electrical converter as seen in Figure 1

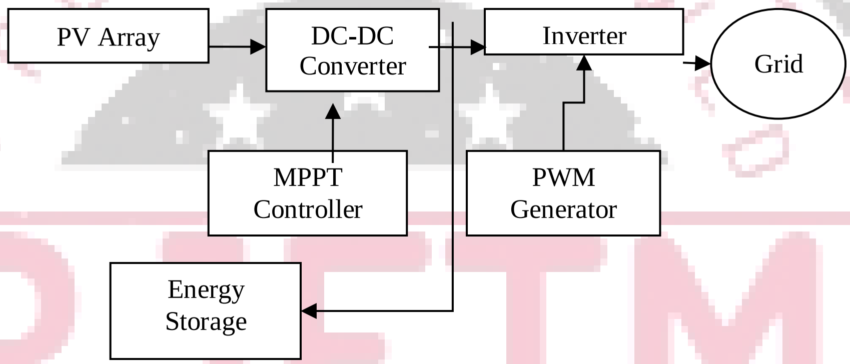

Figure 1: Block Diagram of a Solar Power Generation System

1.2 CONSTANT VOLTAGE MPPT METHOD

The constant voltage (CV) methodology is that the plainest MPPT algorithm that's based on regulation the array voltage to trace the MPP voltage V_{MPP}. The PV array voltage is adjusted around VMPP relating to the reference voltage V_{Ref} that's the regulated array voltage. It's supposed to match the V_{Ref} to V_{MPP} within the most correct adjustment. If this can be not the case, then the algorithm tries to accumulate the most adequate adjustment around the V_{MPP}. The CV algorithm assumes that the irradiance and temperature variations on the cells don't cause to significant changes on V_{MPP} and so, the V_{Ref} are often kept constant throughout the operation of algorithm.

The flow chart of the CV MPPT operation is illustrated in Fig. 2 wherever the PV array voltage is needed to be measured at the start of the algorithm. The algorithm doesn't involve the other input data. The measured array voltage V_{PV} is employed to line up the duty-cycle of dc-dc converter. Then the duty cycle is updated at every turn by comparing the array voltage to reference voltage. Once the array voltage is bigger than reference, the duty cycle is reduced within the next step or vice versa.

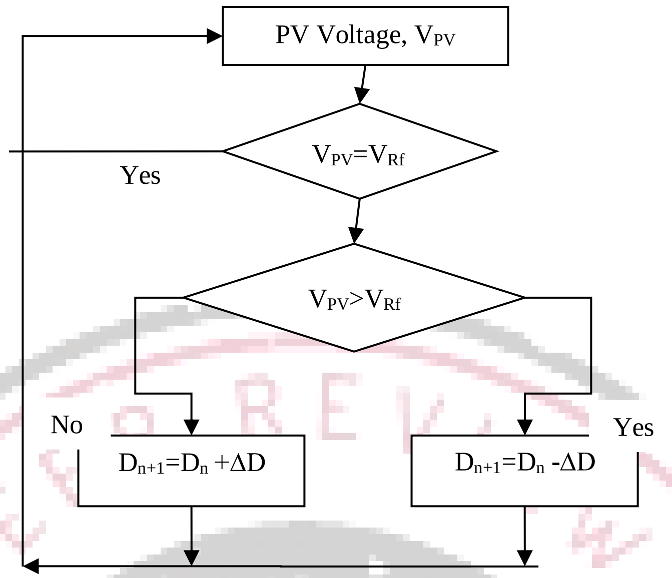

Figure 2: Flowchart of the Constant Voltage MPPT Method

2. *HYBRID RENEWABLE ENERGY GRID SYSTEM WITH PSO-MPPT WITH BACKSTEPPING AND FUZZY INVERTER CONTROLLER*

Grid connected hybrid renewable energy system is simulated and analyzed in this research work. The overall block diagram of the system under discussion is shown in Fig. 3. The system consists of a solar panel, wind system and fuel cell system with particle swarm optimization with maximum power point tracking with backstepping charge controller, battery packs, AC/DC converter (output voltage can be varied) and Fuzzy logic controller for power improvement. In this system, the load has been supplied by DC, not AC. Such as, grid synchronization, where Information about phase angle of the grid voltage is required to transfer the power from converters. To avoid the complications, a simple yet efficient system has been proposed.

RES Interfacing inverter acts as the shunt active filter here. DC link voltage is to be maintained constant for the satisfactory performance of the shunt active filter, DC link voltage is sensed and is compared with the reference value, and the error is then processed with the fuzzy controller.

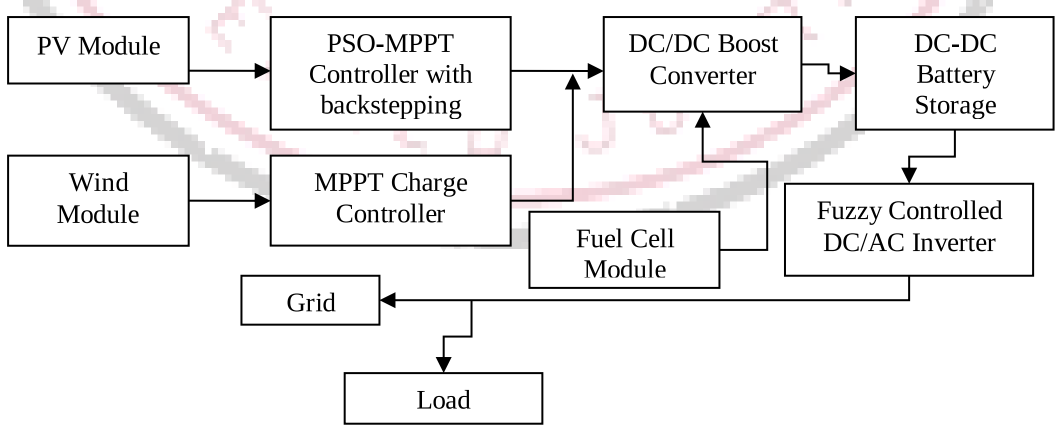

Figure 3: Block diagram of Scenario II (Hybrid RE System with Fuzzy Controlled Inverter)

3. PSO MPPT TECHNIQUE WITH BACK STEPPING CONTROL

A typical MPPT method should be used to integrate PSO algorithm to controller.The flow diagram of an MPPT based on PSO algorithm is shown in Figure 3.4. The operation shown in the flowchart can be analyzed in five steps: initialization, fitness evaluation, updating of the best individual and overall value, updating of the speed and position of each particle and determination of convergence. In the first phase, the particles are randomly initialized in the distribution space or initialized on the described grid nodes that cover the search space [14].

Likewise, the initial velocity values are randomly defined. The fitness value of each particle is evaluated in the second step in which the suitability assessment is performed to provide a candidate solution for the objective function. The best individual and general fitness values are determined in the third phase

where pbest_i and gbest are determined. Thus, the positions will be updated and replaced with the best fitness values if they are found. The speed and position of each particle are updated in the fourth step. The last step in the flowchart examines the convergence criterion. If the criterion is satisfied, the process is complete. Otherwise, the iteration number is incremented and the procedure returns to step 2.

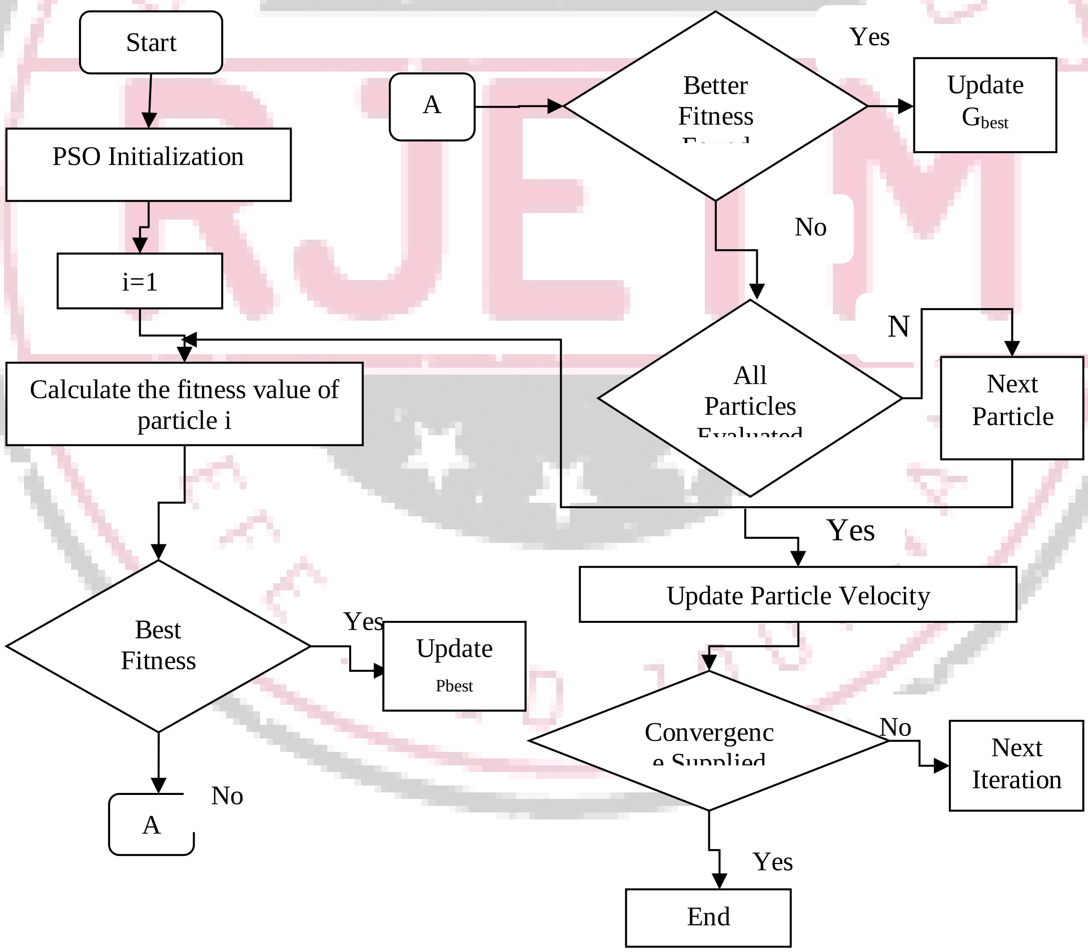

Figure 4: PSO-MPPT Technique

4. RESULTS

The system consists of a solar panel, wind system and fuel cell system with particle swarm optimization maximum power point tracking without back stepping controller, battery packs, AC/DC converter (output voltage can be varied) and PI controller integrated inverter control for power improvement. In this system, the load has been supplied by DC, not AC. Such as, grid synchronization, where Information about phase angle of the grid voltage is required to transfer the power from converters. To avoid the complications, a simple yet efficient system has been proposed.

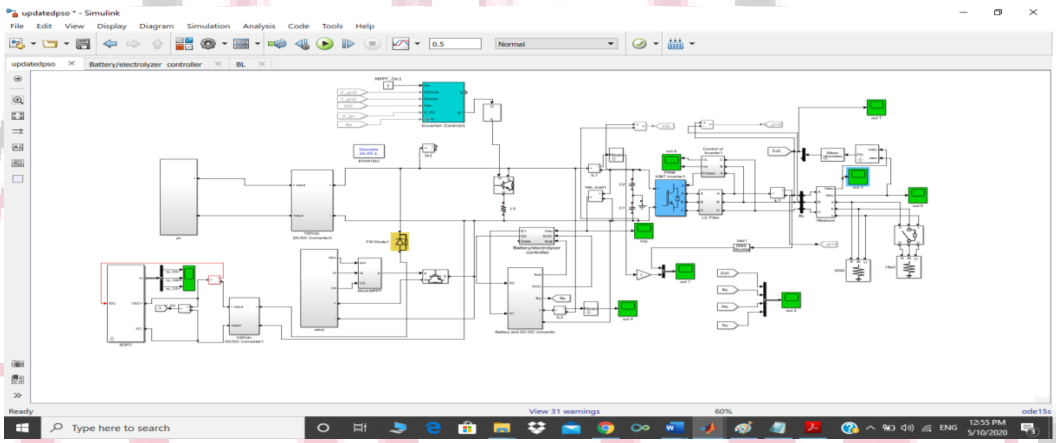

Figure 5: MATLAB Simulink Model of Hybrid RE System with PSO-MPPT and PI Controlled Inverter

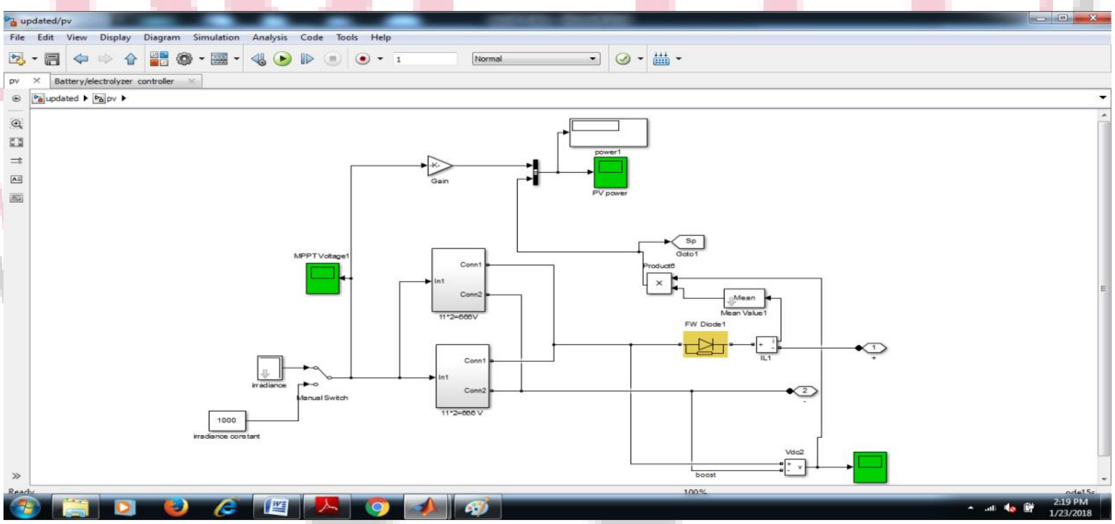

Figure 6: MATLAB Simulink Model of Solar RE System with PSO-MPPT Controller

The simulation results are presented to illustrate the operating principle, feasibility and reliability of this proposed system

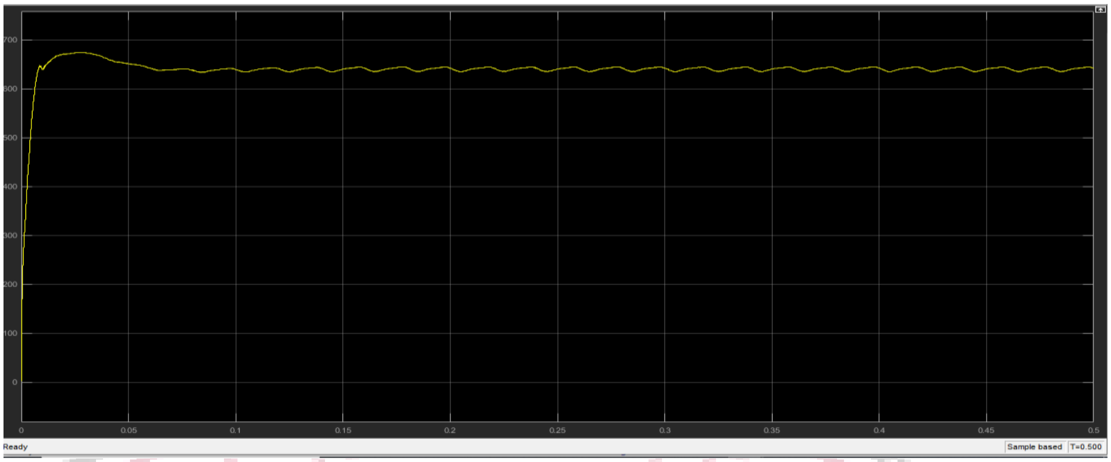

Figure 7: DC Voltage obtained in Hybrid RE System with PSO-MPPT and PI Controlled Inverter

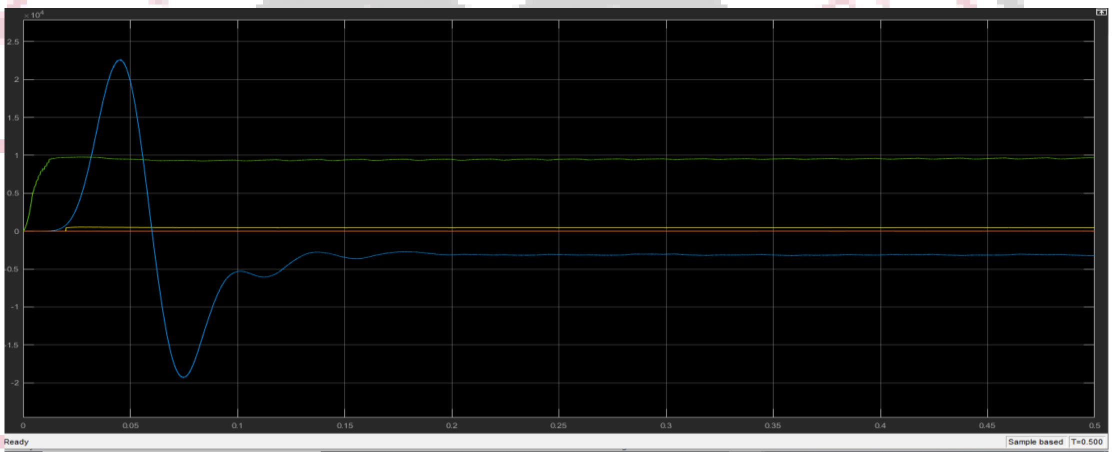

Figure 8 : Power Obtained in Hybrid RE System with PSO-MPPT and PI Controlled Inverter

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