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Study on PV & Wind Hybrid Power System with Fuzzy Logic Controller in MPPT with Standalone System in Simulink

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Abstract: In the period of modern technologies villages of many countries are not electrified. To supply electrical energy (power) to such villages non-conventional hybrid electrical systems are more convenient. The above paper shown is based on a solar and wind hybrid system that is provided with a bi-directional converter and battery storage system to give cheap and reasonable power to village areas of the world. Combined solar and wind systems can supply the supreme power to the load but at a certain working point that is called as a MPPT. For solar and wind systems a FLC-based method is used in MPPT. In the solar and wind system maximum power point tracking is used for giving rise to the reference voltage for the primary stage of the DC-DC buck-boost converter. The combined power system is assessed with the use of unsteady irradiation and temperature of the sun and at vacillating wind speed. The put forward method comes up with an up to the mark paramount power behavior of the combined system at all working situations. To merge two sources, by engaging the proportional-integral switch to another platform of DC-DC buck-boost converter in the two merged solar and wind systems the DC bus voltage is kept persistent. When the eccentric energy source can't supply enough power to the load then the battery storage system comes to an action to provide energy that is stored in it. The whole system was patterned and imitated in the MATLAB/Simulink domain. The aggregate introduced the evidence of the combined system design.

IndexTerms **- Solar PV system, Wind energy conversion system, Combined power system, DC-DC Buck-Boost converters, Fuzzy logic based MPPT.**

I. INTRODUCTION

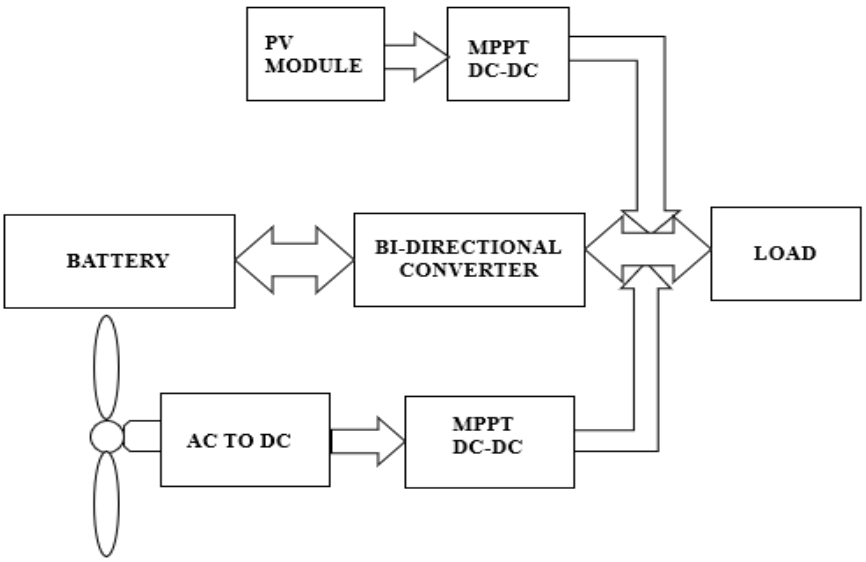
For the remote areas of some undeveloped nations non-conventional energy sources like sun irradiations and temperature and wind can be used for the generation of electricity. Solar and wind are easy to find natural sources of energy that are available for plenty of use and are a kind of energy that make electricity at tremendous speed. Though wind and solar energy have some drawbacks that they can't make electricity when the atmospheric conditions aren't suitable for the system. This paper is made to prove that by using the bi-directional converter, battery storage, MPPT with FLC, and the two systems solar and wind to generate maximum amount of power. This project is simulated and analyzed by the generation procedure from a solar and wind system which is further attached to the DC load. The above details mentioned are simulated with electronic components with the help of MATLAB/Simulink.

Industrialization and globalization are making human to go forward and to make innovations for the better requirement of energy. But in the 21 centuries, countries in globe are only running towards the industrialization and globalization, no one is trying to clear up or decrease the use of fossil fuels that are going end one day and the also cause lot of pollution in the world so now time has come to rapidly shift towards the non-conventional energy sources with great growth rate. But the sun energy is the hero among all the non-conventional energy sources that is available everywhere on this globe. The Solar energy system that requires photovoltaic plates their production needs to be grown rapidly because solar energy is environmental defense.

Electrical inverter that converts AC to DC is present in the solar photovoltaic that is joined to grid. When the grid demands are fulfilled, the excess amount of power that left can be transferred to the battery bank to store power through the bi-directional converter. But when the generation of the system is less and demand form the load side is more, in that case the stored power in the battery bank can came to a used with the bi-directional converter to fulfill the demand of the load. The DC-DC buck boost converter is used because when the voltage of the system is high the buck converter lowers the voltage and when the voltage is

low the boost converter higher the voltage as per the need. Harmonies always get produced, when the power converters are used in the system. In electrical industries the problems regarding the improvement of the sensitive power electronics circuits are tremendously increasing because the use of the is also increased in industries and households as well with the modernization and privatization. The useless current following in the source side cause loss, that results to the harmonic distortion of the source voltage. This harmonic distortion causes the mis operation of relays, mains. So, due to this the reduction of harmonic distortion is very important. The technique which makes harmonic current of equal in magnitude and opposite in is shunt active power filter. This power electronic device has fast response and flexibility. The design scheme of fuzzy logic controller-based technique is a combination of 20th century power system components and power electronics devices.

Fig.1: Block diagram of proposed system

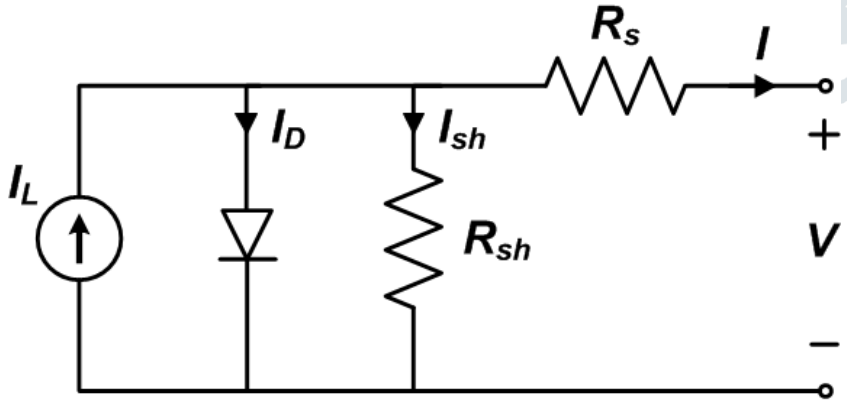


I. RESEARCH METHODOLOGY

3.1 Solar cell modeling

Semiconductor has thin layers of p-n junction based on solar cell; the electrical qualities that changes especially very small such are called as Shockley diodes. Hence, the solar based cell has less comparable circuit that source is joined in collateral with the diode. as represented in Fig. 2. Hence, the equations are as follows.

Fig.2: Solar Cell's Circuit



$$I = I_{PV,CELL} - I_{DIODE} \quad (1)$$

$$I = I_{PV,CELL} - I_{O,CELL}[\exp\left(\frac{q+v}{\propto+k+T}\right) - 1] \quad (2)$$

Where:

$I_{PV,CELL}$ = Current generated by the incident light.
I_{DIODE} = Shockley diode.
$I_{O,CELL}$ = Reverse Saturation current.
q = Electron charge (1.6021×10^{-19}).

k = Boltzmann constant (1.3805 x 10^{-23}).
T = PN junction diode Temperature.
$\propto$ = constant by preference (between 1 to 2).

3.2 Designing of Generators in Wind Turbines system

The wind turbine with particles contains the generator system of the wind turbine, For electromechanical conversion a 3-∅ controlled rectifier with a dynamic permanent synchronization mechanism.

3.2.1 Designing of the wind turbine

Mechanical energy is a convert product of wind energy and that's the main principle of the wind turbine. The wind turbine power is shown below:

$$P_{turbine} = \frac{1}{2} C_p(\beta, \lambda) \rho \pi R^2 V_v^3 \quad (3)$$

The demonstration of tip speed ratio is given by

$$\lambda = \frac{R \times \Omega turbine}{Vv} \quad (4)$$

The PMSG's mathematical model is stated as the equations (5) and (6) [8]:

$$V_z = -R_y i_h - L_q \frac{diy}{dt} + \omega_e L_d i_d + \omega_e \lambda_m \quad (5)$$

$$V_d = -R_y i_h - L_d \frac{did}{dt} + \omega_e L_y i_y \quad (6)$$

The electromagnetic torque expression is be stated as:

$$T_{em} = \left(\frac{3P}{2}\right)[(L_d - L_q) i_q i_d + i_q \lambda_m] \quad (7)$$

The mechanical v-shaped speed and electrical v-shaped speed relation is stated as follows:

$$\omega_e = \frac{P}{2} \Omega_{turbine} \quad (8)$$

3.2.2 Modeling of the three-phase uncontrolled rectifier

The PMSG's prompt voltage is given by:

$$V_{an} = V_m \sin \omega t \quad (9)$$

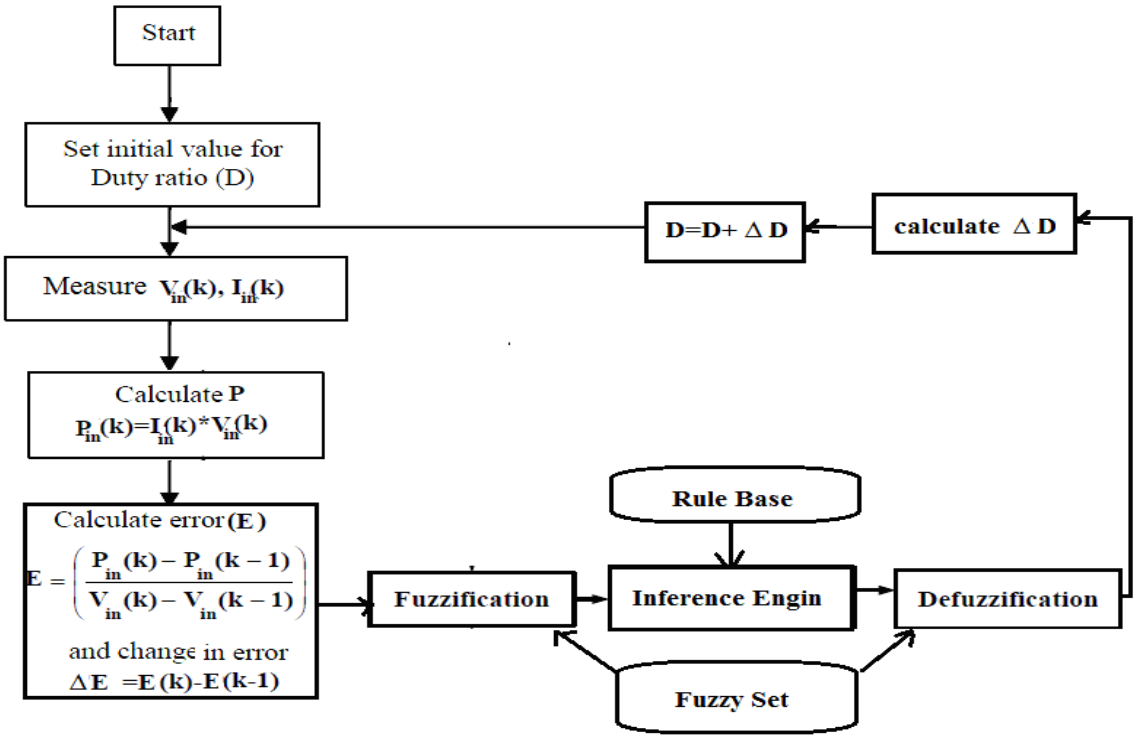
$$V_{dc} = \frac{3\sqrt{3}}{\pi} V_m = \frac{3\sqrt{6}}{\pi} \lambda_{m\text{-}eff} P\Omega \quad (10)$$

$$I_{dc} = \frac{\pi}{\sqrt{6}} I_a \quad (11)$$

3.3 MPPT

At this stage the fuzzy logic is made in maximum power point tracking. And it starts operation under different wind speed and different sun's irradiation as well as temperature. The system was so made that it can have two different maximum power point tracking with different values and membership functions and rules and connected to both the system as well as to dc-dc buck-boost converters. The below figure is the flow chat that how fuzzy logic controller works.

Fig.3: Flow Chart of MPPT



3.4 Buck-Boost Converter

The comparison of reference voltage is made with output voltage to make an error which leads to determine the switching characteristics of the signal duty cycle, after controller the dc-dc buck-boost converter is connected to the system. To lower and higher output voltage of the system switching signals are applied to the MOSFET. The work of converter is to make the voltage stable to particular value with variable currents. The switch on and off time i.e., duty cycle D the converter is used.

3.5 Fuzzy Logic Controller

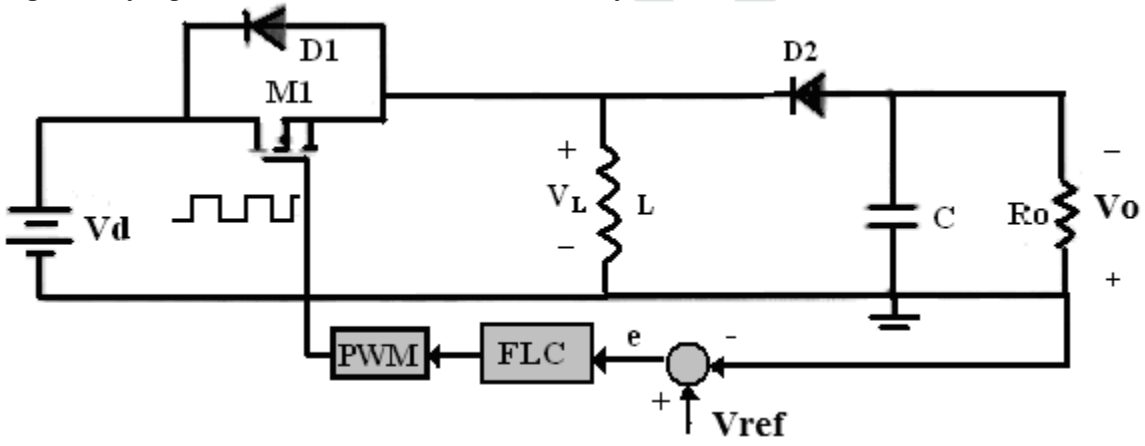
The control algorithm is stated and which depends on the variables and the rules in the system. By varying the switching duty cycle the output voltage from converter is controlled. To calculate errors in the system the output voltage reference and voltage are differentiated.

$$T(w) = X(w) - C(w) \quad (12)$$

voltage error is also planned as;

$$pe(w) = T(w) - T(w-1) \quad (13)$$

Fig.4: Fuzzy logic controller with buck-boost converter system



The circuit represented is of bidirectional direct current to direct current converter as above in Figure. 4. The working of the converter made to be operated continuously. The converter made voltage to buck and boost as per the need of the system to feed load as well as the power to be stored in the battery banks for storage purpose.

3.6 Battery

The main work of battery is to a storage the excess amount of power that was being generated by the hybrid systems and when the system fails to generate the amount of power that is been supplied to the dc-load then the bank's stored energy is supplied to the dc-load to fulfill the requirements. To a common direct current link, the sun and wind non-conventional energy source is connected commonly with a common voltage to the battery bank. Transfer of power either form system to load or form battery to load to the same voltage DC bus. To make the power flow is both the directions the converter is used.

3.7 Bi-Directional Converter

The power flow in both sides is handled by the bi-directional converters because of permissible ability to flow the power different directions, as per the requirements of the system. The implementation of the bi-directional converter in our combined power system is to have the excess amount of power to transferred to the battery bank storage system and when both the solar and wind systems are unable to produce power due to atmospheric conditions that excess amount of power to be circulated to the load side of the power system.

IV. RESULTS AND DISCUSSION

The above paper has the combined combination of the solar and wind system on the basis of the perform analysis of the hybrid system that has included with the battery bank storage system with the bi-directional converter and both the non-conventional energy system connected to maximum power point tracking along with the fuzzy logic controller that is joined to dc-dc buck-boost converter to fulfill the needs to the load. This above paper also represents the performance analysis solar and wind system under various breezy conditions. A descriptive designing of two solar and wind system components are discussed in different environment with maximum power point tracking. The fuzzy logic controller-based algorithms, that shows how to extract maximum voltage form both solar and wind system and to fed towards to the dc-dc buck-boost converter was included. This fuzzy logic-based controller can pluck out high power from both sun and wind system independently and can provide to the dc load. To maintain battery bank charging from power system and discharging the battery banks from load side was made limited under every working conditions so that the power flow should be maintained.

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