MODELING AND ANALYSIS OF HYBRID ENERGY SYSTEM WITH FUZZY LOGIC CONTROLLER

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Abstract
This paper presents the analysis and operation strategies for a micro grid by using the hybrid systems. A hybrid system includes the combination of different systems such solar-diesel, solar-wind etc., but in this paper a solar- wind system was used for the analysis of a micro grid. A CSI CUK converter is used to integrate the renewable energy sources to the main DC bus. In this paper, a direct driven PMSG is used with a variable speed control method whose strategy is to capture the maximum wind energy below the rated wind speed. The fuzzy logic controller has been taken at the inverter side. Incremental conductance MPPT method has been implemented to track the maximum power in case of solar panels. The entire model was simulated in MATLAB/SIMULINK software.
Keywords: Microgrid, PV, MPPT, Fuzzy logic controller

I.Introduction:

Combined PV-Wind hybrid generation system utilizes the solar and wind resources for electric power generation. Individual solar and wind energy sources have unpredictable randombehaviour. As throughout the day, solar energy is present but due to the sun intensity and unpredictable shadows by clouds, birds, trees, etc., the solar irradiation level varies. Due to this cause solar energy is unreliable and less used.

The project addresses dynamic modelling and control of a wind-PV-battery hybrid system with versatile power transfer. The hybrid system can operate in three different modes, which include normal operation without use of battery, dispatch operation, and averaging operation.

II.Modeling of PV cell:

A PV array is combination of several PV modules connected in series and parallel. A module is the combination of no of cells connected in series and parallel.

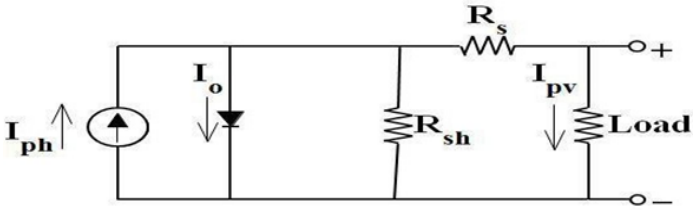


Fig:2.1Circuit diagram of single PV cel

Photo-current of the module:

$i_{ph} = [i_{scr} + k_i (t - 298)] * \lambda / 1000$…….(1)

Reverse saturation current of the module:

$I_{rs} = I_{scr} / [\exp(qv_{oc} / nkT) - 1]$……..(2)

Saturation current:

$$I_0 = I_{rs} \left[\frac{T}{T_r}\right]^3 \exp\left[\left[qE_{go}/BK\right]\left(\frac{1}{T_r} - \frac{1}{T}\right)\right]$$ ….(3)

The current output of the module:

$I_{PV} = N_p I_{ph} - N_p I_o [\exp\{(q * v_{pv} + I_{pv} R_s) / N_S AKT\} - 1]$….(4)

Wind Turbine Modeling:

A wind turbine in the proposed micro grid simulation study is modelled by an aerodynamic input torque which drives a wind generator. In order to explain the wind turbine model here, the mechanical power(pm) captured by the blades of a wind turbine is described as follows.

$$P_O = \mathbf{1/2(\rho A V_W)} (V_W)^2 = \mathbf{1/2 \rho A V_W}^3 \ldots(5)$$

Incremental Conductance Method:

This method uses the PV modules output current and voltage information based on polarity changes in the derivative of power with respect to their voltage, which is zero at the MPP, positive at the left of the MPP, at negative at the right of the MPP. These voltage polarity changes characteristics lead to the following

criterion that identifies whether PV panels reach their MPP or not.

(dP/dV)MPP=d(VI)/dV…..(6)

0=I+VdI/dVMPP…..(7)

dI/dVMPP = -I/V….(8)

Both the wind turbine and the photovoltaic array must be adjusted to operate at their point of maximum power. Many different maximum power point tracking (MPPT) algorithms like perturbation observation method, incremental conductance method have been developed and widely used for such systems.

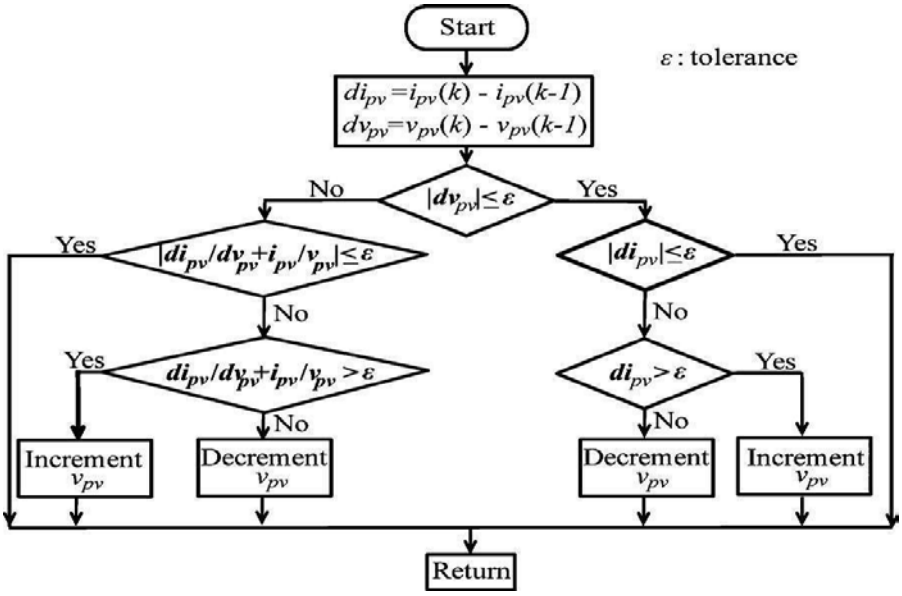
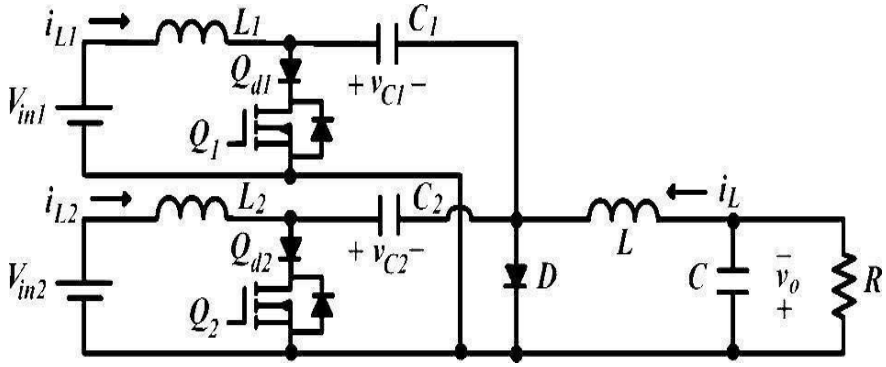


Fig:2.2Flow chart of Incremental Conductance Method

CUK converter:

The CUK converter is a type of dc/dc converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is a exactly a Boost converter followed by a Buck converter with a capacitor to couple the energy.. As the other c

Fig:2.3CUK dc-dc converter



Fuzzy Logic Controller:

The Fuzzy logic model is empirically-based, relaying on an operators experience rather than their technical understanding of the system. FL requires some numerical parameters in order to operate such as what is considered significent error and significent rate-of – change-of-error, but exact values of these membrs are usually not critical unless very responsive performance is required in which case empirical tuning would determine

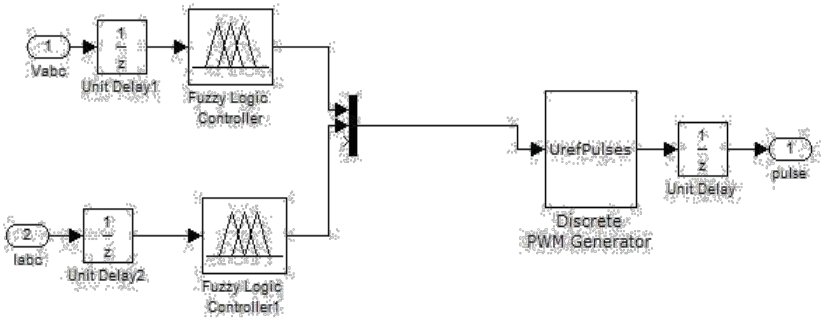


Fig: 2.4 Fuzzy logic controller simulation diagram

III.Simulation results:

MATLAB is used in wide range of applications, including signal and image processing, communication, control design, test and measurement, financial modelling and analysis, and computational biology. Add on toolboxes extended the MATLAB environment to solve particular classes of problems in these application areas.

Simulation Model:

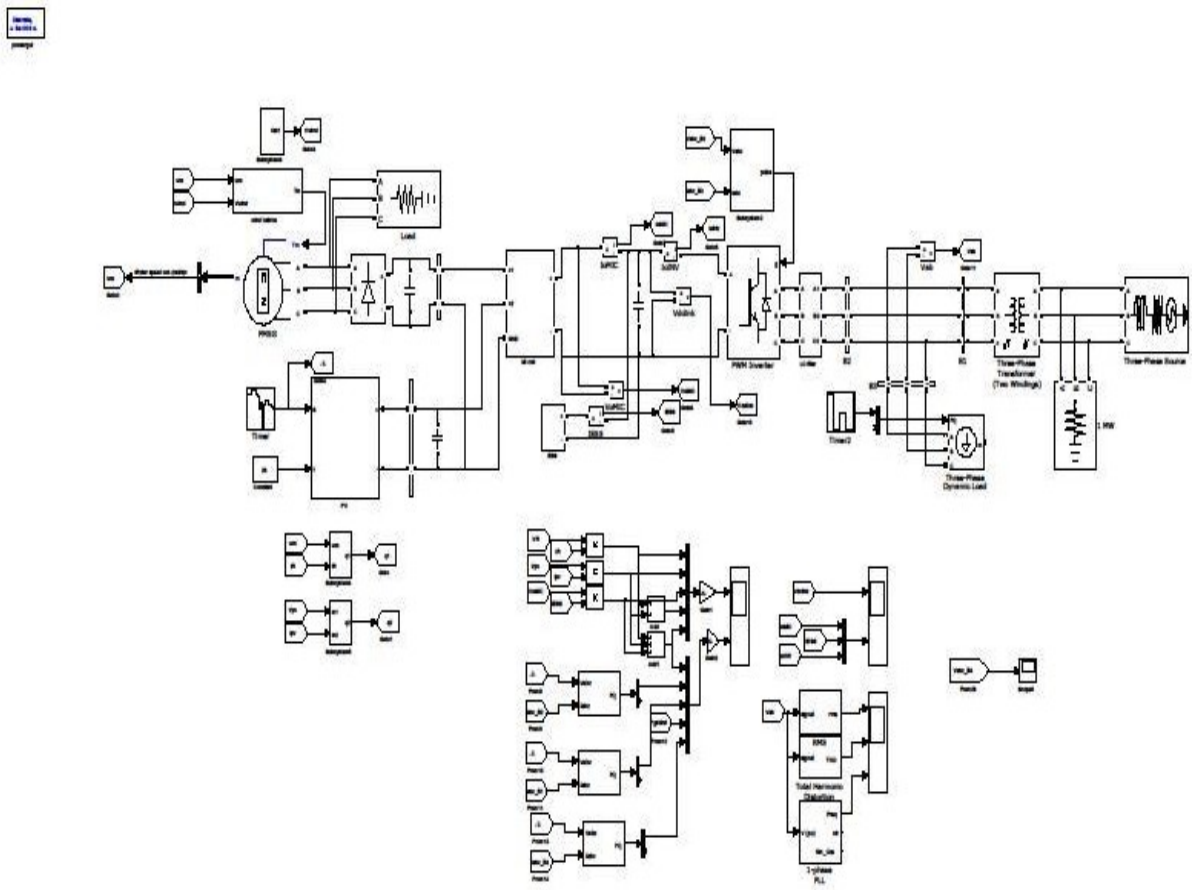


Fig: 3.1 Simulation model of the proposed system

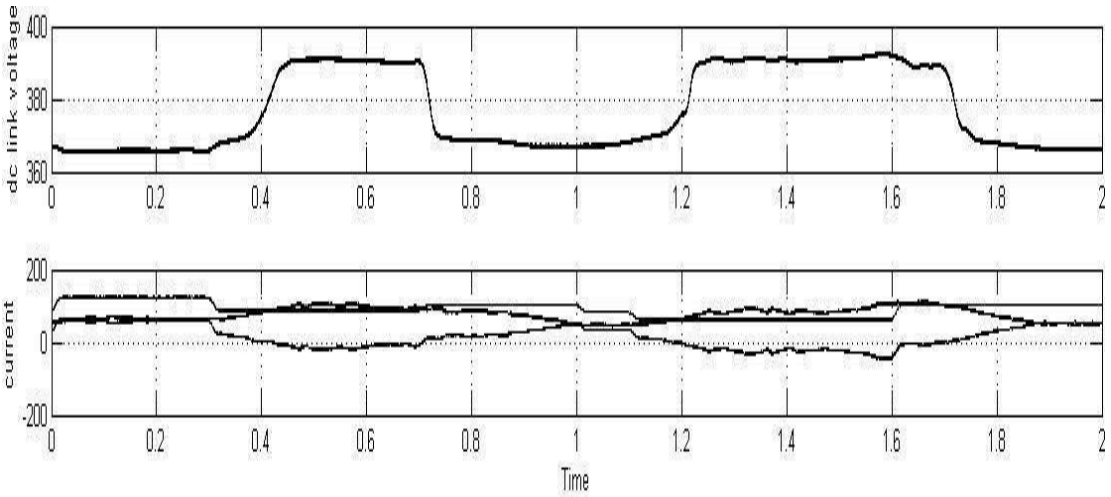


Fig: 3.2DC link voltage, IMIC,IESS,IINV waveforms

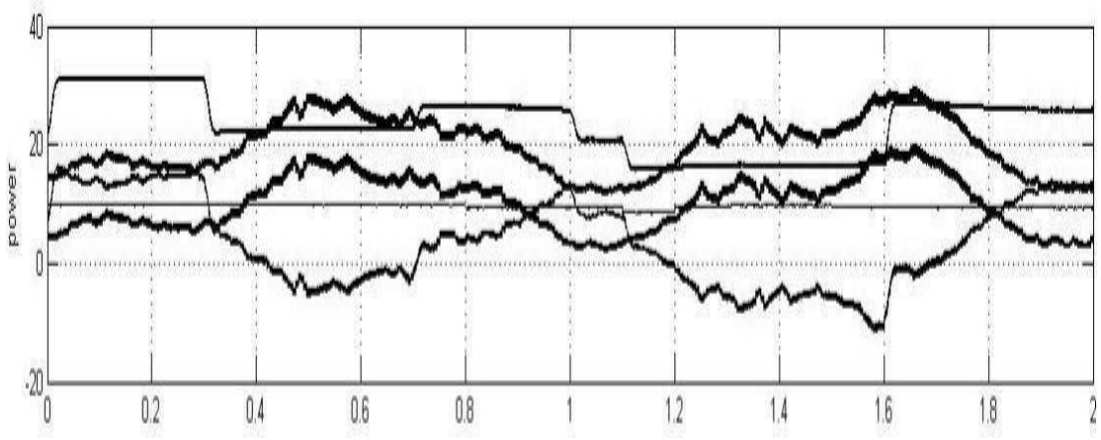
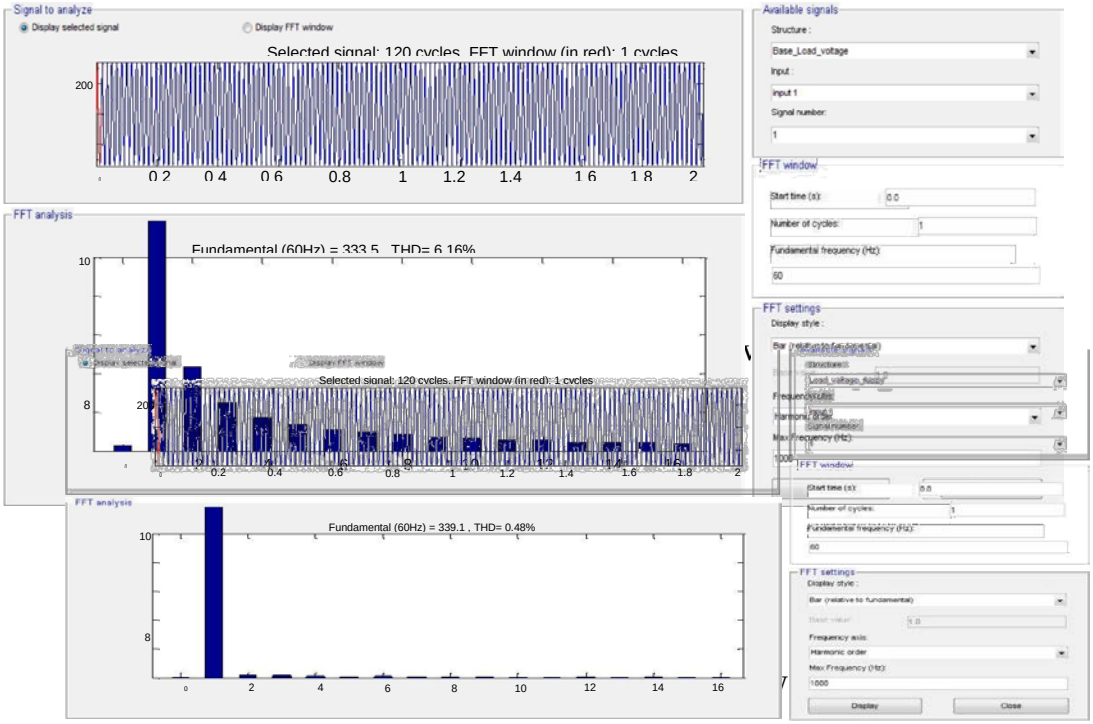


Fig: 3.3Power output wave form



IV. Conclusions:

This Paper presented the analysis of a microgrid primarily powered by Solar and wind energy systems. This paper focused on the MPP tracking of the renewable micro-energy source power variations under the load

demand changes and the variable dispatch power to the distribution grid.The fuzzy logic controller has been taken at the inverter side.. In addition, this study also considered an ac wind generator and a grid side inverter in the proposed model. The control strategies proposed in this paper are feasible when deploying a sustainable microgrid with a dc-dc converter which can reduce its productioncosts. The simulation results have shown that the system performance was improved when Fuzzy logic controller has been used.

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