Dynamic Modeling of Hybrid Power System with MPPT under Fast Varying of Solar Radiation

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Abstract:

Generally, Photovoltaic and Wind energy systems are need of the hour from electrical energy system point of view. This paper also proposes the concept of hybrid grid energy system which consists of PV as well as other renewable energy sources such as wind, Fuel and ultra-capacitor based systems. In this paper an Incremental Conductance based MPPT technique is proposed in order to control the solar Power. The performance of this hybrid system is observed by simulation case study demonstrate the usefulness of the proposed system.

Introduction:

At present, by far most of imperativeness demand on the planet relies on upon fossil powers, for instance, petroleum, coal, and trademark gas that are being exhausted brisk. One of the real outrageous issues of a perilous climatic devation is one of these invigorates start things, carbon dioxide; these are achieving remarkable hazard for life on our planet [1]. Fossil powers can have as a choice some renewable imperativeness sources like daylight based, wind, biomass, consequently; among them on the wind essentialness system which changes over the twist imperativeness into power, as it were, used as a piece of low power applications. The wind generator is chosen for its positive concentrations including being sans carbon and boundless; likewise, it doesn't realize bustle for it is without moving parts and with size-independent electric change profitability [2].

Coincidentally, the power delivered by a wind imperativeness system is affected by atmosphere conditions; for example, at stormy or in cloudy periods, it would not make any power or application. Moreover, it is difficult to store the power made by a twist system for quite a while later. The best procedure to beat this issue is to arrange the twist generator with other power sources, for instance, PV, Electrolyzer, hydrogen stockpiling tank, FC structure, or battery on account of their incredible components, for instance, high viability response, measured creation, and fuel versatility [3, 4]. This paper concentrates on building up a recreation model to plan and size the half and half framework for an assortment of stacking and meteorological conditions. This reenactment model is performed utilizing Matlab and SimPower Systems and results are displayed to confirm the adequacy of the proposed framework. The proposed framework associated half and half vitality era framework is appeared in figure 1.
Wind Turbine

Wind turbines are classified into two types: Horizontal and Vertical axis. A vertical axis machine has its blades rotating on an axis perpendicular to the bottom. There are various obtainable styles for each and every kind has its own benefits and downsides.

PHOTOVOLTAIC ARRAY MODELING:

In the PV network of electrical phenomenon, cell is the necessary part. For the raise in appropriate current, high power and potential difference, the sunlight dependent cells and their region unit joined in non-current or parallel fashion called as PV exhibit are used. In practical applications, each and every cell is similar to diode with the intersection designed by the semiconductor material. When the light weight is absorbed by the electrical marvel sway at the point of intersection, it gives the streams at once. The (current-voltage) and (Power-Voltage) attributes at absolutely unpredictable star intensities of the PV exhibit are represented in figure 3, whereas the often seen existence of most electrical outlet on each yield is shown in power diagram 2.

\[ I = I_{ph} - I_D - I_{sh} \]  
\[ I = I_{ph} - I_o \left[ \exp \left( \frac{q V_D}{nKT} \right) \right] - \left( \frac{V_D}{R_S} \right) \]

Solar cell output power is given as the product of V and I
a. **INC MPPT Technique:**

In this technique the change of PV voltage can be obtained with respect to MPP voltage peak power. Figure 4 shows the PV power curve for incremental conductance method.

The relation for conductance in incremental and instantaneous can be expressed in three cases:

\[
\frac{\partial P}{\partial V} = \frac{\partial (VI)}{\partial V}
\]

The power expression,

\[
P = V \times I
\]

Differentiate the power equation with PV terminal voltage,

\[
\frac{\partial P}{\partial V} = \frac{\partial (VI)}{\partial V}
\]
At MPP,

\[ \frac{\partial p}{\partial v} = 0 \]

The modified equation expressed as:

\[ \frac{\partial I}{\partial V} = -\frac{I}{V} \]

This MPPT technique controls PWM signal for boost converter until \((dI/dV) + (I/V) = 0\) is obtained. Figure 5 shows the INC MPPT flow chart.

**MODELING OF FUEL CELL**

For fuel cells the electrochemical procedure begins at anode side, at the anode side stream plate channels brings H2 particles. Impetus in anode isolates hydrogen on protons H+ through film that proton go to cathode and over outer electrical circuit the electrons that go to cathode. By utilizing of impetus at the cathode oxygen is joined with hydrogen protons and electrons for development of H2O and warmth. This response is communicated in underneath conditions [9]

\[
H_2 \rightarrow H_2O + 2e^- \text{(Anode)}
\]

\[
\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O \text{(Cathode)}
\]

\[
\Delta g_g = \Delta g_g^{o_f} - RT_f \ln(PH_2) + 0.5 \ln(PO_2)
\]

\[
E = -\left( \frac{\Delta g_g}{2F} \right)
\]
Electron-proton chemical bonds formation and breaking are the result by Cathode and anode activation losses, at zero current through membrane hydrogen proton migration is causes by the parasitic electrochemical reactions. The fuel cell voltage drop is expressed as

\[ V_{act} = V_0 + V_a (1 - e^{-C_i}) \]

**Fuel Cell Equivalent Electric Circuit**

![Fuel Cell Equivalent Electric Circuit](image)

Figure 9 equivalent circuit for fuel cell system

\[ V_{fc} = E - V_c - iR_{ohm} \]

\[ C \frac{dV_c}{dt} + \frac{V_c}{R_{act} + R_{conc}} = i \]

\[ V_{fc} = E - \left( \frac{R_{act} + R_{conc}}{s( R_{act} + R_{conc} + 1) + R_{ohm}} \right) i \]

**Electrolyzer:**

The main purpose of electrolyzer is to decompose the electrical current into water molecules such as hydrogen and oxygen. From Faraday’s law, the hydrogen production rate in particular associated electrolyzer cell is generally proportional to electrodes electrons transfer rate [11] [12], the expression for hydrogen production is expressed in below equation and shown in figure 10

\[ n_{H_2} = \eta_F \frac{n_i e}{2F} \]

Here, faraday efficiency is defined as relation between theoretical and actual values of hydrogen produced in electrolyzer. Let us consider the electrolyzer operating temperature is 40°C, efficiency of Faraday is expressed by:

\[ \eta_F = 96.5X \left[ e^{0.09 \frac{i_e}{i_0} - 75.5} \right] \]
Results and discussion:

Figure 10: Block Diagram for Electrolyzer

Fig : I-V Graph

Fig : P-V Graph

Fig 8.3: Simulation Diagram of Hybrid Power System
Fig 8.3: Hybrid Power System output powers (a) Wind Power (b) Solar Power, (c) Hydrogen (d) Fuel Cell Power

Fig 8.3: Simulation Diagram of Proposed Circuit

Fig 8.4: With normal INC-Conductance Method (a) Irradiance, (b) Solar Voltage (c) Solar Current (d) Solar Power

Fig 8.4: With Modified INC-Conductance Method (a) Irradiance, (b) Solar Voltage (c) Solar Current (d) Solar Power
CONCLUSION

The adequacy of disengaged power frameworks are assessed in MATLAB PC condition. The framework considered is twist alongside PV and fuel cells to meet the heap which is profoundly worthwhile for remote and distant burdens. It is watched that the proposed design is minimal effort and having less many-sided quality. The brace is used to supply to the neglected power request by the disconnected power frameworks on the off chance that they are associated with the brace. All in all, the execution of segregated framework is better and monetarily valuable to the clients everywhere and is exceptionally successful for provincial zones to meet remote burdens.

REFERENCES


[9] G.Srinivasarao, Dr.K.Harinadhreddy “A review on design and development of high reliable hybrid energysystem with droop control Techniques”-