Advanced Fuzzy Controller of Fault Analysis in a Grid Tied Hybrid System

G. Arun* and D. Seshi Reddy

Electrical and Electronics Engineering, KL University Greenfields, Vaddeswaram, Guntur District - 522502, Andhra Pradesh, India; arunghnt@gmail.com, dseshireddy@kluniversity.in

Abstract

Background/Objectives: This paper focuses on the intelligent extraction of ideal force by utilizing different MPPT techniques and its dispatch from a grid tied hybrid generation system containing a synchronous generator based wind generator and a Photo-Voltaic generator. Methods/Statistical Analysis: Although maximum power point tracking techniques such as Fuzzy Controller and OPPT technique such as PSO algorithm is implemented for PV generator, power extracted from PV system is a fuzzy capacity of the dc joins voltage, its rate of progress and the inverter active current component. This is to reduce high frequency oscillations in the dispatched power obtained from PV generator. Such an extraction of the optimum power is considered as a novelty of this paper. Findings: The performance of this is also verified under different fault conditions which are occurred at place of grid system. And the harmonics caused by this system is reduced by using active power filter. Application/Improvements: The effectiveness of the novel power extraction strategy proposed along with the fuzzy PD+I control of converters results in and brings about an upgraded power dispatch and a reduction in the oscillations of the currents.

Keywords: Electrical Battery Storage Systems (EBSS), Fuzzy Logic Controller (FLC), Squirrel Cage Induction Generator (SCIG)

1. Introduction

Expanded penetration of renewable vitality into force network gave birth to a few difficulties those are experienced in integrating such sources amongst themselves as well as with the grid. Despite the fact that the vitality got energy from such sources is environment cordial, the force and voltage acquired from such sources fluctuates haphazardly with the variety of climate. Moreover, non-linear power converters, utilized for molding the yield from such sources, distort the waveform and thus degrade the nature of dispatched power in this way influencing touchy burden associated to the grid. Weariness of fossil powers, their unsafe impact on environment and an expanding power request results in increasing the infiltration of renewable vitality sources into the utility network. Li-particle batteries however immoderate have higher force thickness and can withstand higher charging/releasing cycles than lead-corrosive batteries while NiMH batteries are costlier and consequences for the atmosphere regardless of having higher force thickness than Li-particle batteries. LCPV collectors utilized as a part of this work have a level of fixation of 2.2 X which does not require any additional following component furthermore, cooling plans for their cells. The utilization of such cells can enhance sun based power extraction effectiveness to 20%-25% than level plate gatherers, with the utilization of basic mirror reflection with great optical productivity. Greatest force extraction is crucial from both the LCPV and WECS for expanding system efficiency. Fluffy logic control has turned out to be vastly enhanced than traditional control for greatest force point following especially under differing contributions for renewable sources. Following of most extreme working force point are done utilizing source side assortments bringing about high frequency components in the dc join voltage.
2. System Dynamics and Modeling

2.1 Grid Integration

Reactive power capability: the successful wind forms generally maintain the power factor over a range of approximately 0.95.

In this paper a PMSG based wind energy conversion system-low conversion photovoltaic half breed framework with Li-particle battery stockpiling is considered, sustaining energy to a neighbourhood load and the framework as appeared in Figure 1 where $C_{dc}$ is the dc join capacitor. The turbine coupling shaft is demonstrated as one mass drive framework as the evaluated rotor rate is low with a higher number of rotor poles for the PMSG. Such shaft element with lesser torsional losses and thick erosion expanding transmission efficiency through the shaft.

![Figure 1: Hybrid System](image1)

**2.2 PV Generation System**

In electrical phenomenon photovoltaic system, the cell is that the basic part. Photovoltaic exhibit is nothing however sun cells area unit connected asynchronous or parallel for increasing required current, voltage and high power. Every cell is comparable to a diode with a tangency fashioned by semiconductor material. It delivers the streams once light weight consumed at the intersection, by the electrical phenomenon impact. It are often seen that a most electric outlet exists on every output power graph.

The Figure 3 shows the (I-V) and (P-V) characteristics of the Photo Voltaic array at totally different star intensities. The electrical circuit of a cell is that the present supply in parallel with a diode of a forward inclination. The present equation of the cell is given by:

$$I = I_{pho} - I_{di} - I_{shu}$$

$$I = I_{pho} - I_o \exp \left( \frac{q V_D}{nKT} \right) - \left( \frac{v_D}{R_S} \right)$$

Power output of solar cell is $P = V \times I$

![Figure 2. Electrical circuit of photovoltaic moduling.](image2)

**3. Maximum Power Point Tracking**

The potency of turbine, electrical device is improved by MPPT after they set to control at purpose of most power. In several procedures MPPT the foremost in style proce-

![Figure 4. P&O flow chart.](image3)
dures are: Progressive electrical phenomenon technique, Perturb and Observe, symbolic logic, neural networks. Initial electrical phenomenon array reference voltage and therefore the rotor speed for generator and for the turbine area unit modified if the 2 systems output powers area unit doesn’t match to their most powers.

4. Perturb and Observe MPPT Algorithm

In this type of MPPT calculation requires outer to repeatedly perturb the array voltage and in this way measure the subsequent change in the yield power. The fundamental hindrance of this calculation is it drives the system to oscillate around MPP rather than continuously tracking it. This algorithm fails under rapidly changing environment. So that is this algorithm is not preferable under rapidly changing environmental conditions. The advanced version P&O is incremental conductance algorithm it is designed to overcome the drawbacks of P&O calculation under quickly changing natural conditions in this algorithm the increase and decrease operations are performed continuously to achieve maximum power point in one direction. The output is continuously compared with previous to have better output.

5. Particle Swarm Optimization (PSO) MPPT Algorithm

PSO is a bio inspiring computing tool. It is developed based on the activities of birds, fishes, and other animals. The behaviour of these creatures are observed and developed by two persons James Kennedy and Russell Eberhart. Who are psychiatrist and electrical engineer? There are a number of particles in this algorithm which move around in space to search for the best or optimum value. These particles are provided with initial velocities and certain constants and values at the beginning. Each particle of the system has a certain velocity and learning constants. It then moves in the space, randomly and then adjusts according to the experience collected from other particles.

6. Basic PSO Function

- **Velocity function**
  \[ v_{ii}(k_i + 1) = v_{ii}(k_i) + r1(i(p_{best} - x_{ii}(k_i))) + r2(i(g_{best} - x_{ii}(k_i))) \]

- **Position function**
  \[ X_{ii}(k_i + 1) = X_{ii}(k_i) + V_{ii}(k_i + 1) \]
  
  - **i** – particle.
  - **k** – discrete time.
  - **v_{ii}** – velocity variable of a particle.
  - **X_{ii}** – position variable of a particle.
  - **p_{best}** – personal best position of a particle.
  - **g_{best}** – global best position of a particle.
  - **g(1,2)i** – arbitrary numbers between interval [0,1].

7. Flow Chart OF PSO Algorithm

Figure 5. PSO flow chart.

8. Fuzzy Logic Controller

In the previous section, control strategy based on PI controller is discussed. But in case of PI controller, it has high settling time and has large steady state error. Keeping in mind the end goal is rectify this issues, this paper proposes the application of a Fuzzy Logic Controller (FLC) shown in Figure 7. Generally, the FLC is one of the most important software based technique in adaptive methods.
As compared with previous controllers, the FLC has low settling time, low steady state errors. The operation of fuzzy controller can be explained in four steps.

- Fuzzification.
- Membership function.
- Rule-base formation.
- Defuzzification.

Figure 6. Basic structure of fuzzy logic controller.

In this paper, the membership function is considered as a type in triangular membership function and method for defuzzification is considered as centroid. The error which is obtained from the comparison of reference and actual values is given to fuzzy inference engine. The input variables such as error and error rate are communicated in wording of fuzzy set with the linguistic terms VN, N, Z, P, and P in this type of mamdani fuzzy inference system the linguistic terms are expressed using triangular membership functions. In this paper, single information and single yield fluffy deduction framework is considered. The number of etymological variables for information and yield is assumed as 3. The number of rules are formed as 9. The input for the fuzzy system is represented as error of PI controller. The fuzzy rules are obtained with if-then statements. The given fuzzy inference system is a combination of single input and single output. This input is related with the logical operator AND/OR operators. AND logic gives the output as minimum value of the input and OR logic produces the output as maximum value of input.

9. Wind Turbine

Wind turbines square measure classified into two types: Horizontal and Vertical axis. A vertical pivot machine has its cutting edges turning on a hub opposite to the bottom. There square measure variety of obtainable styles for each and every kind has bound benefits and downsides.

Figure 7. Basic diagram of wind turbine.

The wind turbines with a squirrel cage generator are equipped with a soft starter mechanism for reactive power compensation as coop generators consume reactive power. This generator and also the turbine rotor area unit coupled through a shell, because the best rotor and generator speed ranges are totally different.

Figure 8. SCIG diagram.

10. Electrical Battery Storage System

The change of Alternating Current to Direct Current is finished by electrical Battery energy system, generally it’s based on power electronic converters. Here the working of battery i.e., transformation of power into energy for putting away reason. By utilizing DC power Batteries may charges and in some cases releases. For this purpose Bi-directional force electronic converters are required for directing force stream in the amongst batteries and vitality systems. In view of assortment of battery it’s having fluctuated benefits and bad marks like value, weight, size, and power and vitality capacity. Lithium-Ion, Lead-Acid, Nickel cadmium, Nickel Metal hydride these are essential types of vitality stockpiling advancements. High release rates are accomplished by Lead-Acid batteries; these batteries are giving a more grounded answer for uses of vitality stockpiling.
11. Simulation Diagram and Results

In this paper the simulation can be done w.r.t figure shown in 1 in two cases such as with filter and without filter under fault conditions.

Figure 9. Wind speed and solar irradiance.

Figure 9 shows the wave form for the power which can be obtained from both wind and PV systems. Figure 9(b) represent the produced power from the Photovoltaic system w.r.t to change in time and Figure 9(a) shows the power which is generated from the wind energy generation system.

Case 1: Simulation Results for Hybrid System under Fault without Filter

Figure 10. Without filter.

Figure 10 show the simulation results for voltage and current across load. In this case a fault is created during the period 0.2 s to 0.6 s. In this period some distortions occur during and after fault as shown in Figure 10. In order to overcome these harmonics we use a shunt active filter.

Case 2: Simulation Results for Hybrid System under Fault with Filter

Figure 11. With filter.

Figure 11 show the simulation results for voltage and current across load. In this case a fault is created during the period 0.2 s to 0.6 s. In this period the distortions occur because of presence of fault is cleared by using shunt active filter as shown in Figure 11.

12. Conclusion

This paper shows the techniques to emphasize peak power from the LCPV sun oriented generator and ideal force from a PMSG based direct determined wind power generator to give vital energy to the area load and the grid. Both the power extractions are done brilliantly utilizing fluffy rationale control however wind power being the dominant contributor amongst the two, inject high frequency oscillations in the dc join power. Thusly extraction of force from this generator by the proposed technique focuses to stabilize the dc join voltage and lessen dynamic force confound at the inverter yield. The framework capacities in network supporting mode by dispatching the dynamic force created and responsive force remuneration of the heap completely Fuzzy control of the inverter demonstrates best amongst the three methods of operation examined in settling dc join voltage, battery power control, enhanced grid support and improving THD of the power electronic converter output voltage and current. And also from the simulations the harmonics generated by fault is effectively compensated using shunt active filter.

13. References

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