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RESEARCH ARTICLE

Improvement of Transient and Voltage Stability with Photovoltaic Inverters by using Fuzzy Logic Controllers

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ABSTRACT

This paper proposes a fuzzy logic controller (FLC) based PV system fed with the three-phase power grid. Generally large rating PV system is associated with the already existing power system it may affect the grid performance due to inconstancy in nature. In this proposed system, the FLC-based controller is designed to operate the power system in stable condition during faults occurring time also. Solar-fed inverters playa crucial role in operating our proposed system at stable conditions and increasing the reliability, stability, and performance of the system. This paper provides a controlling strategy for a PV system that improves the transient stability of a Synchronous Generator (SG) linked to the utility grid.The suggested FLC control approach causes the PV inverter's DC link capacitors to absorb a few of the kinetic energy stored in the SG during a temporary halt, as shown in the study. In addition, by injecting reactive power into the system, the planned method can increase voltage stability. The results were done through MATLAB Simulation successfully working to the proposed control method.

Keywords: PV Inverters, Voltage stability, Fuzzy Logic Controller

INTRODUCTION

As of overdue, energy frameworks have encountered a massive growth in the entrance of Renewable Energy Sources (RES), which might be usually related to the energy network to improve the power grid performance by using power converters. The increment of the PV energy shows some new specialized difficulties, for instance, temporary steadiness [1], which makes the interest in force frameworks below severe unsettling effects a significant issue. The preferred framework dormancy and lead consultant reaction are reduced for this new framework layout, which may additionally adversely impact the temporary reaction of the rotor point of SGs. In any case, the inverters applied in the PV age deliver novel open doorways, like subordinate administrations to SGs. PV converters might assist with retaining soundness after a framework unsettling have an impact on, for example, a brief out delivered approximately [2]. The GCs of the history of twenty years did not count on the big adjustments in the electricity framework setup regarding the activity of pressure inverters. Indeed, even today, it's far more difficult to appreciate and verify future conditions. Hence, over the past 20 years, GCs have anticipated the RE assets to be separated while an unsettling impact is recognized [3]. This necessity is fine the period of the RE infiltration level isn't huge, which is completed to forestall the deficiency of synchronism. In any case, the GCs have modified to require FRT restriction from RE gadgets in the course of aggravations [4], and that means that the aged unit must live associated with the power framework as well as, additionally, should give a guide in maintaining up with synchronism and voltage solidness. A few nations have laid out ideas that require greater capacities from the PV inverters utilized in disseminated age devices and from PV flora related to the medium voltage transmission matrix. A portion of those principles takes into consideration an MC running mode or in the short end transferring dynamic potential to the matrix whilst giving need to the responsive electricity backing to in addition develop voltage dependability [5]-[7]. A few GCs lay out APRRR for publishing shortcoming interests, as needs to be seen in [8]. In the writing, the FRT limit of PV frameworks in consistence with the GCs has been to an awesome volume researched. For instance, [9] proposes an FRT plan to help the community via infusing responsive electricity, as anticipated in the German GC, and that empowers the electricity first-rate to change in view of a tradeoff between power waves and present-day sounds. The prevalence of large-scale RES in existing power networks has increased over the previous decade due to the global warming concerns of fossil fuel-based power stations and the rising cost of energy generation. PV power plants are among the most popular forms of RES since their costs are constantly falling.

MODELLING OF THREE PHASE POWER NETWORK

The proposed test system shown in figure.1 is considered for transient analysis of the integrated system. The synchronous machine and PV system both are connected in parallel and they are integrated with the grid by means of transmission lines. The PV systems have n PV system as depicted in figure.2, and are restricted by using the MPPT strategy. It is a known fact that the harmonics injected by the nonlinear loads are controlled by using active power filters. The synchronous machine's current components control the torque and flux in the machine by injecting and controlling the PV system. As it is known that this approach depends on the prepared limitsduring the fault the excess energy will not be absorbed by the grid and it was sent to PV inverter's dc link for storage purposes.

Wind System

The Wind system which is the electrical generator of renewable energy, is the component that makes up a wind turbine. We looked at the rotor blade design. A low-rpm electrical generator is the brain of any wind power system. It converts the mechanical rotational power produced by wind energy into electricity to provide power for remote villages. A wind turbine can transform a small fraction (Cp) of the energy that is captured from the wind. The following equation explains how three variables—rotor blade sweeps area (Aw), upstream wind velocity (Vw), coefficient of rotor power (Cp), and mechanical power (Pwt)—are related.

$$P_{wt} = \frac{1}{2} P A_w {V_w}^3 C_{\mathrm{p}}(\lambda, \beta) \quad (1)$$

Solar System

The solar system acts as a renewable energy resource for hybrid microgrids. Solar radiation and PV cell temperature both affect PV power. The PV module has a separate MPPT (Maximum Power Point Tracking) controller from the PMS.

$$Iph = [sc + Ki(T - 298) \times Ir/1000] \quad (2)$$

Irs = Isc/$\left[exp(Qvoc/NSknT)-1\right]$ (3)

Micro Hydro System

The kinetic energy received from the falling water is converted to mechanical power that subsequently transformed the electrical energy by a generator as part of the hydro turbine's basic operating principle. The electrical power produced by the micro-hydro turbine is calculated using the following equation in the proposed model.

$$Phyd = \frac{\eta hyd \times hnet \times \rho water \times Qturbine \times g}{1000\ (W/kW)}$$

FUZZY CONTROLLER FOR IMPLEMENTATION

The overall control scheme for controlling the proposed system is presented in figure.3. Under steady-state operating conditions, the power comes from the PV system is fed to the utility. The dc link controllers receive the active from the dc link and regulate the dc link error voltage. When the dc link error control building block is disable, the transfer of power is made from grid to MC mode. In this situation, dc link receives the power and absorb the kinetic energy so by reducing the effect on synchronous machines transient stability.

SIMULATION RESULTS

Hybrid system response synchronous machines active and reactive power are exposed in figure.4, and figure.5 shows the hybrid system response PV systems active and reactive power, figure.6, Hybrid system response PCC voltage and dc-link voltage, and lastly in figure.7, the hybrid system response inverters currents and synchronous machines rotor angle

This paper proposed FLC and PI controller-based stability enhancement of the grid-connected PV system. FLC decides the optimal gain parameters of the PI controller based on the grid side parameter variations. The benefits of the suggested method are vigorous performance with an increased level of Transient stability and Voltage Stability. The performance of the proposed technique was assessed by means of the comparison analysis with the presented technique.

CONCLUSION

In this paper, the proposed fuzzy logic controller-based solar power system is fed with the grid. Generally large rating PV system is associated with the already existing system it may affect the grid operations due to inconstancy in nature. In this proposed system we design our system in stable even faulty condition and voltage support for LVRT. Solar-fed inverters are playing a crucial role in operating our system at stable and increasing reliability and stability. To achieve transient stability, the proposed control technique causes the SG kinetic energy to be engaged by the dc link capacitors. It also allows for the injection of reactive electricity into the grid to help maintain voltage stability. Results show that the suggested control strategy efficiently ensures the SM's transient stability by reducing rotor angle oscillations within the initial few cycles of the failure.

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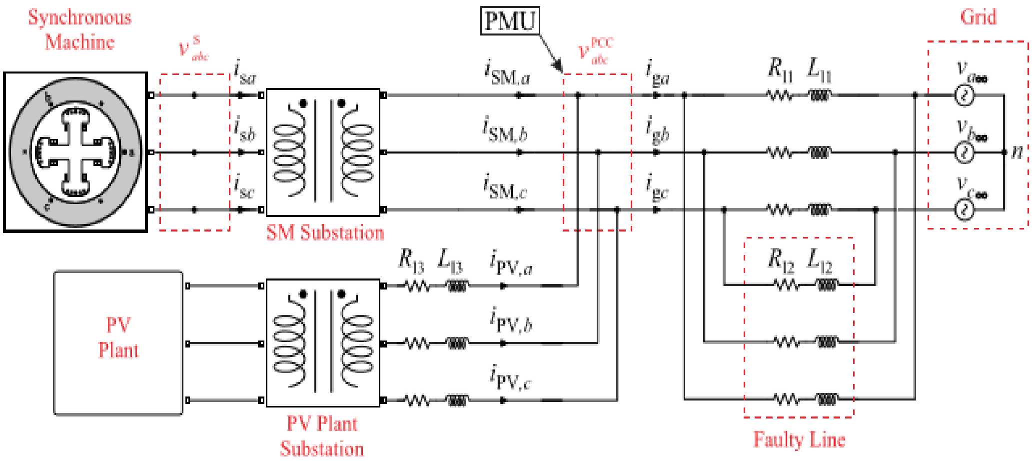

Figure.1: Proposed 3-phase power network for implementation

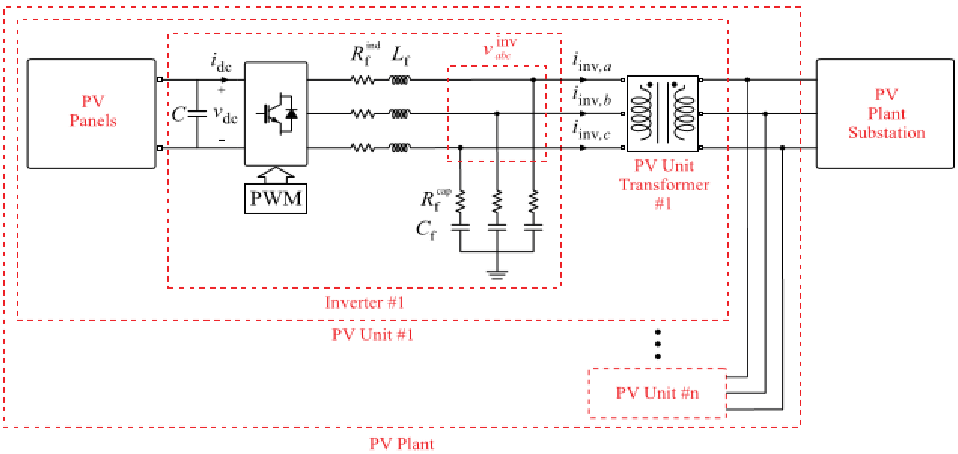

Figure.2: Internal implementation of individual PV unit

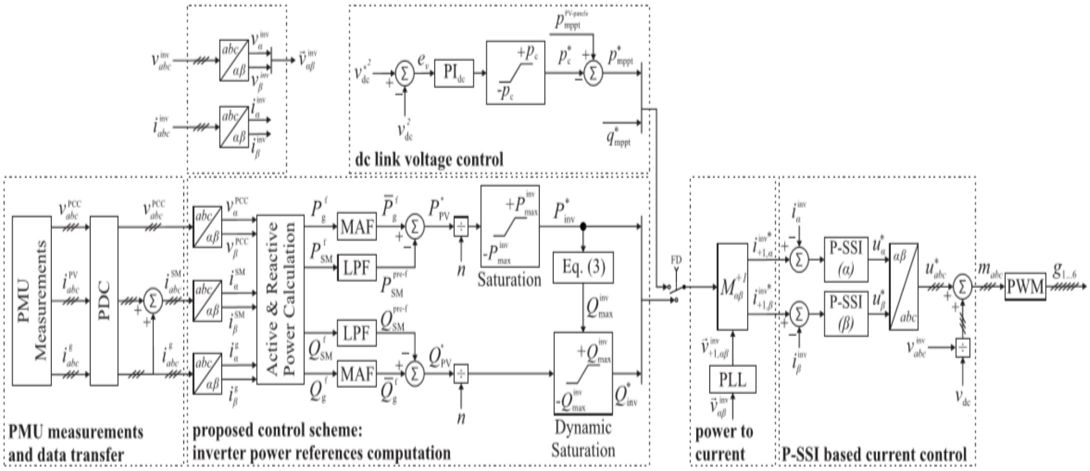

Figure.3: Proposed FLC Controller implementation

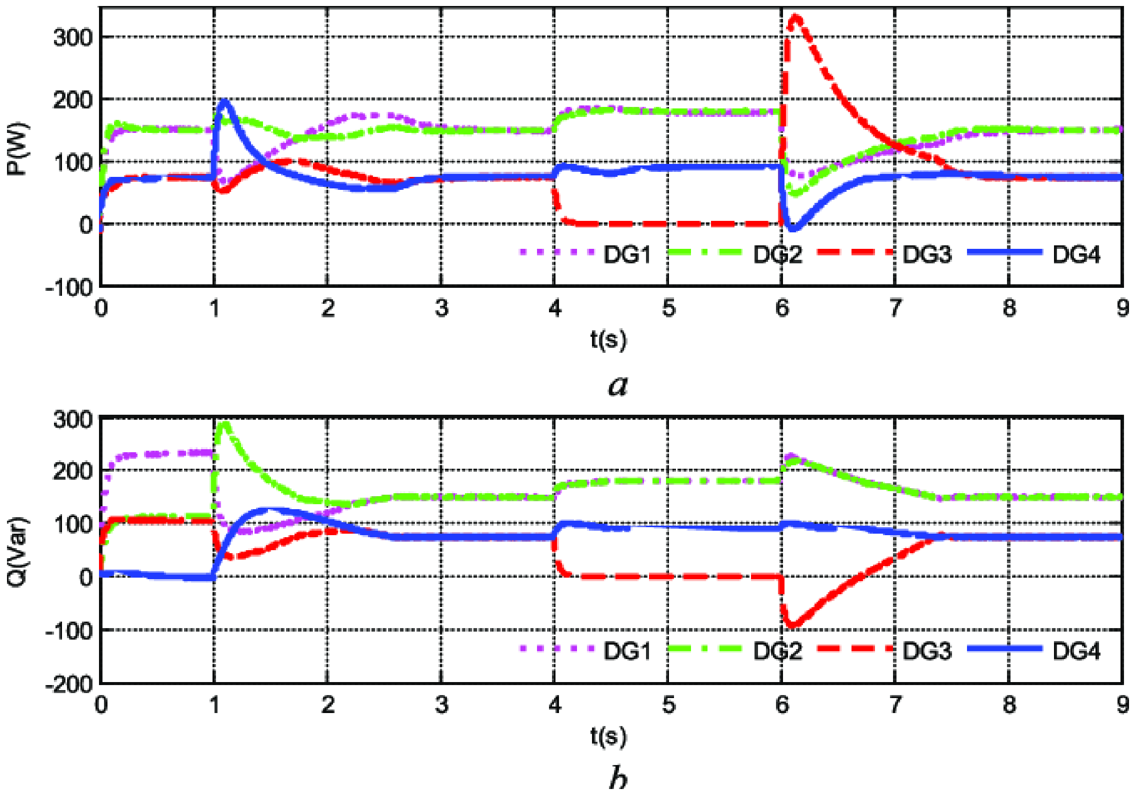

Figure.4: Hybrid system response synchronous machines active power and reactive power

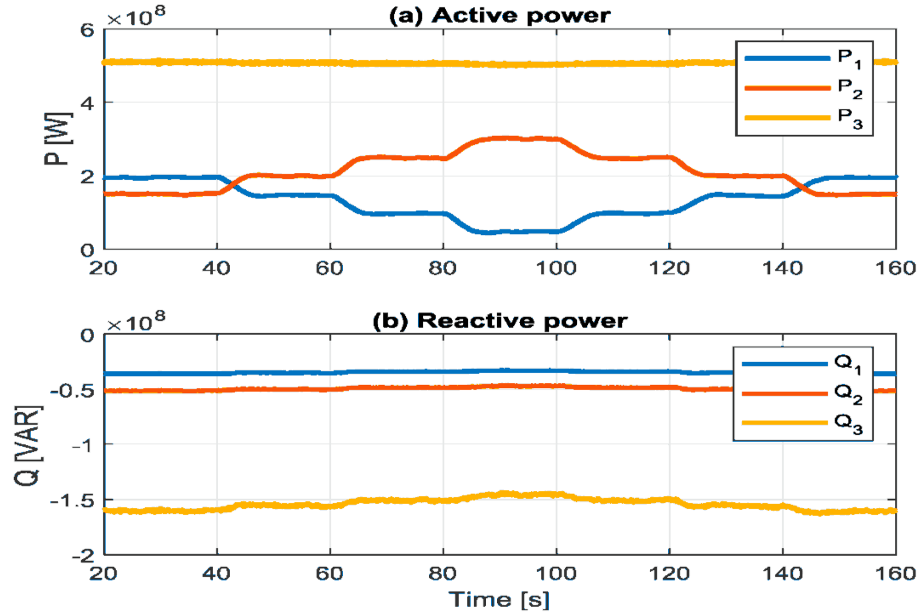

Figure.5: Hybrid system response PV systems active power and reactive power

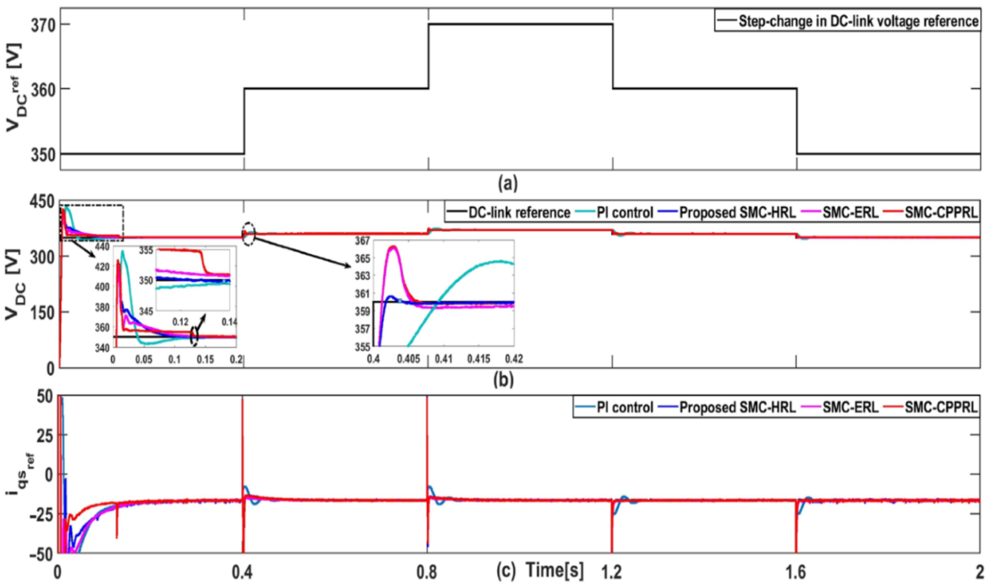

Figure.6: Hybrid system response PCC voltage and dc link voltage

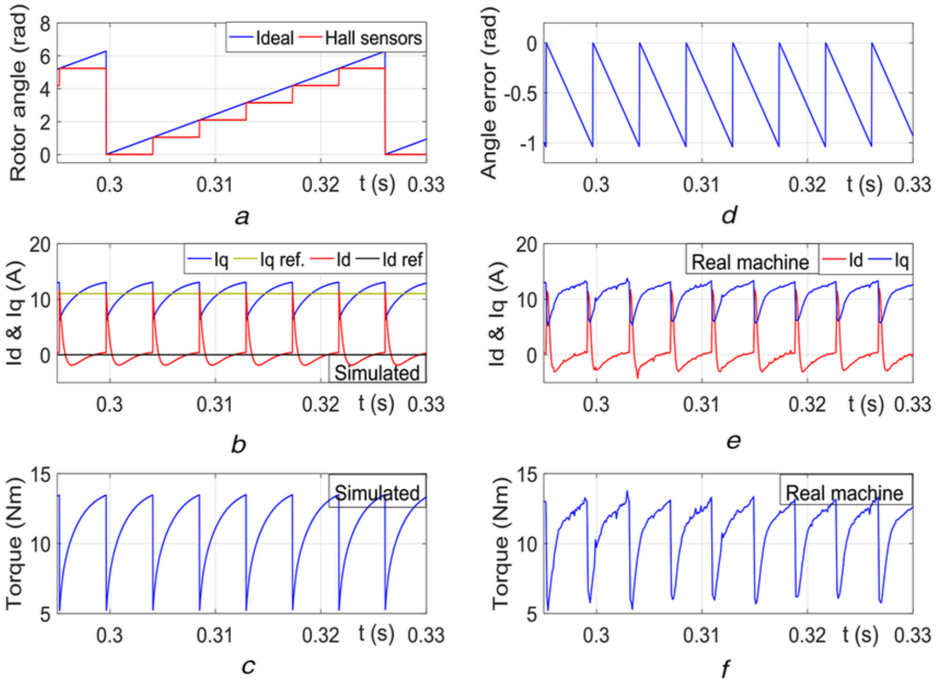

Figure.7: Hybrid system response inverters currents and synchronous machines rotor angle