RURAL ENERGY SYSTEM FOR WIND HYDRO MICROGRID SYSTEM BY USING FUZZY LOGIC CONTROLLER

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Abstract: In this paper a standalone operation of inexhaustible energy based microgrid is proposed. As the wealth of inexhaustible power sources like sun oriented, hydro, wind and so on, are all the more so utilize those inexhaustible energy sources to produce influence by creating microgrids based on wind-hydro. The VSI (Voltage source inverter) with indirect current control is the standard control unit of micro grid. According to the proposed control system VSI provides power quality through reactive power compensation at PCC (Point of Common Coupling), instant load unbalance, regulation of voltage during potential outcomes, suppression of harmonics in nonlinear loads. It is prepared for giving power balance under various changes among the generation, storage and demand units. For legitimate working of VSI, to make PWM exchanging pulses for VSI a reweighted zero attractor least mean square (RZALMS) control estimation is applied. By simulating the proposed network in SIMULINK to analyze nonlinear and linear loads dynamic and normal conditions.

Key points: Wind- Hydro MG, SyRG, RZALMS, battery bank, Power Quality, fuzzy logic.

1.Introduction

In advanced countries of the world like United States of America and western countries, the energy is needed to have an agreeable existence style and for innovative and modern turns of events. The other viewpoint is additionally obvious that there are numerous nations in Africa and Asia, where a few spots are as yet denied of power. Individuals of such places have stale social turn of events and insignificant monetary development and they stay away from fundamental auxiliary administrations like wellbeing, training and so on To fulfill the expanded need of the world just as to offer the essential auxiliary types of assistance to far found places, the separated microgrid [1-3] for country zap can be a respectable choice when contrasted with the ordinary network. By using normal assets like wind, solar irradiation, geothermal and so forth and diesel generators [4-7]micro grids canbe employed.AC and DC microgrids to support the greatest utilization of inexhaustible power and financial use of exhaustible energy sources. The overall energy utilization is accounted for in [8] for all customary (exhaustible derivatives, enormous hydro, atomic and so forth) and inexhaustible (wind, sun based, little hydro and so on) assets. It is accounted for that up to 2020, the utilization of exhaustible energy sources, is to be decreased up to 76% and renewables are relied upon to grow up to 16%. This investigation shows that the renewable energy sources are assuming control over the exhaustible energy sources gradually.

The object is to substitute exhaustible energy sources with renewable energy sources, are the intake of these sources, which has increased the cost of fuel [9] and their impact on natural disfigurements like ozone harming substances, an Earth-wide temperature boost and ascend in medical problems viz. debilitated hearing, disabling perceivability, tipsiness etc.[10, 11]. The innovative work in power gadgets, have made uses of environmentally friendly power to develop quick and smooth [12]. The electric force is given to the distant places either by diesel generator (DG) sets or accessible inexhaustible assets, for example, wind, hydro, sun based and so on The DG sets power cost on distant applications and way of life becomes costly however the inexhaustible assets are monetary in generation yet are entirely inconsistent as their generations are season subordinate. Consequently, the combination of renewable energy sources can be a promising innovation to achieve the unwavering quality. In, photovoltaic system are examined with different control plans. Such systems comprise of DC-DC and DC-AC converters. Another combination of converters, is called hybrid converters, having exchanging between converters.

A hybrid microgrid is accounted for in with wind and diesel assets. In such microgrid droop control is used for frequency regulation of AC bus. In, aninexhaustible microgrid for energy management is accounted for having design with two converters, one is AC-DC and other is a DC-DC converter for smooth power flow. While in the proposed work, a solitary VSI (DC-AC converter) as the control unit and one DC-DC converter is used for MPPT (Maximum Power Tracking). In such system, the control unpredictability and cost of the system just as maintenance, are decreased. In standalone operations, voltage and frequency regulation and power management, are significant angles as revealed. To secure battery over charging dump loads are utilized. P&O (Perturb and Observe) and sliding mode controls are utilized for MPPT and PWM pulse generation. Also, wind is entirely problematic asset because of its variable and eccentric nature.

To conquer this issue, to be accessible in all seasons a hydro power station with battery storage employed. Because of strength and low maintenance squirrel cage induction generator is employed in hydropower generation units. However its proficiency is poor and frequency regulation is required. To get appraised frequency and voltage with the reactive power uphold by utilizing a capacitor bank the hydro power generator with a SyRG (Synchronous Reluctance Generator) is proposed. , the maintenance and the losses are diminished because of no slip rings and rotor windings, and its influence proficiency is improved. For wind power generation the variable speed PMBLDC (Permanent Magnet Brushless DC) generator is utilized. Due to the trapezoidal EMF and practically quasi square shape flows it gives higher normal power than the alternator.By using P&O strategy MPPT of wind power is accomplished.

This MG capacities with regards to control changing during wind changes and burden demand assortments. A reweighted zero attractor least mean square (RZALMS) control approach is realized in the microgrid VSI, which is the guideline control unit of the framework. RZALMS animates the association rate and has lower mean square blunder than the standard LMS. With the help of logical exhibit, RZA-LMS is better on the standard LMS in both transient and consistent state execution for scanty and non-meager systems.

It offers decrease in sounds of nonlinear burdens, voltage guideline at load assortments, receptive force pay subject to framework need. It similarly administers changed force stream among various units for instance wind-hydro generators, the battery stockpiling and loads. The essential responsibility of the paper is according to the accompanying, a singular VSI control based microgrid is made. Also, and the breeze intensity of PMBLDCG is changed over into DC power using a diode rectifier. Along these lines, this geology has reduced the overall cost of the framework. The PMBLDCG needn't waste time with sensors, for instance, speed sensor, position sensor and wind speed sensor for MPPTcontrol, consequently further diminishing the cost. A reweighted zero attractor least mean square (RZALMS)control approach is executed in the microgrid VSI for snappy responses during predictable state and dynamic conditions. Generators used are liberated from upkeep and having high profitability.

I. INTRODUCTION

II. MG CONFIGURATION AND CONTROL STRATEGY

Fig. 1 depicts the endless based microgrid including hydro and wind sources. The hydro power is make during SyRG, a consistent power generator and this power is dealt with to the AC loads. The PMBLDCG is used to make the force from wind power at variable rates and a diode rectifier is used to change over it into DC power, which is dealt with to the lift converter for MPPT using P&O control methodology. This removed force is passed on to the AC loads through a VSI and excess made force is taken care of in the battery bank related comparing to the VSI. This VSI is related with the hydro power generator (SyRG) and burdens at PCC through interfacing inductors (Lf). A capacitor bank is related at SyRG terminals to push receptive capacity to MG for voltage improvement. The arrangement data of proposed MG are given in Appendices. To work MG in pleasant manner, it must give incredible quality force as overseen sinusoidal voltage and recurrence.

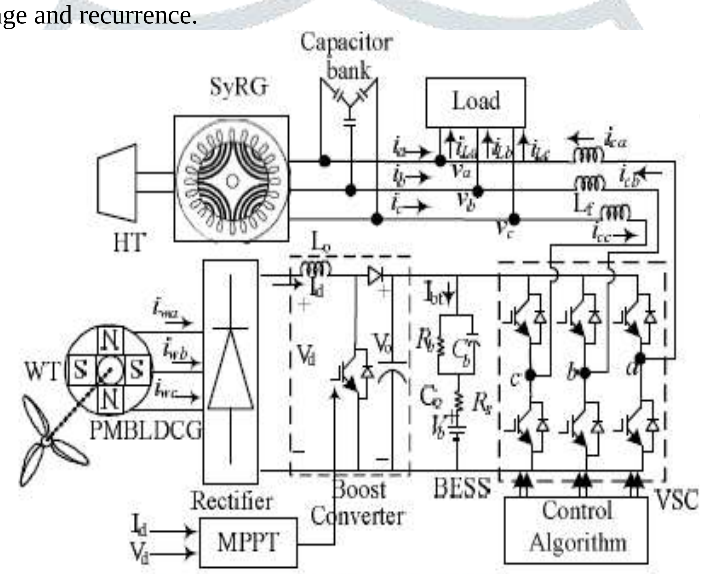


Fig1. Wind Hydro microgrid configuration

This work gives MG execution a reweighted zero attractor least mean square (RZALMS) control way to deal with support a zero attractor for separating between zero taps and non-zero taps as appeared in Fig.2.The boundaries μ (step size), i_{La} (current of phase 'a'), $u_{\_pa}$ (template of in phase), $u_{\_qa}$ (quadrature format), σ and ψ (little constants) are utilized in the control approach. Phase voltages are registered from line voltages as,

$$v_{\_a} = {}^{1}/_{3}\left(2v_{\_ab} + v_{\_bc}\right) \quad (1)$$
$$v_{\_b} = {}^{1}/_{3}\left(-v_{\_ab} + v_{\_bc}\right) \quad (2)$$
$$v_{\_c} = {}^{1}/_{3}\left(-v_{\_ab} - 2v_{\_bc}\right) \quad (3)$$

From phase voltages the terminal voltage Vt is derived as,

$$V_{\_t} = \sqrt{\left[2\left(v_{\_a}^2 + v_{\_b}^2 + v_{\_c}^2\right)/3\right]} \quad (4)$$

In-phase template of phase 'a' voltage as,

$$u_{\_pa} = v_{\_a}/V_{\_t} \quad (5)$$

Similarly other two in-phase templates for phase 'b and c' $(u_{\_pb}, u_{\_pc})$ Are also achieved.

The quadrature voltage templates of three phase voltages as,

$$u_{\_qa} = \left(-u_{\_pa} + u_{\_pc}\right)/\sqrt{3} \quad (6)$$
$$u_{\_qb} = \left(3u_{\_pa} + u_{\_pb} - u_{\_pc}\right)/\sqrt{3} \quad (7)$$
$$u_{\_qc} = \left(-3u_{\_pa} + u_{\_pb} - u_{\_pc}\right)/\sqrt{3} \quad (8)$$

The RZALMS approach is used to estimate the active load power current component from the load current at (x)thsample for phase 'a' is derived as,

$$i_{pa}(x) = i_{pa}(x-1) + \mu u_{\_pa} e_{pa} - \frac{\sigma \sin\left(i_{pa}(x-1)\right)}{1+\Psi\left|i_{pa}(x-1)\right|} \qquad (9)$$

The lesser extents taps are explicitly shrank by RZALMS. The reweighted zero attractor impacts just those taps for which sizes are practically identical to 1/ψ and there is little shrinkage utilized on the taps who's $i_{pa}(x-1) \gg {}^{1}/_{\Psi}$along these lines, the inclination of RZALMS can be decreased. The error among wanted and genuine yields $e_{pa}(x)$at x^{th}sample, is determined as,

$$e_{pa}(x) = \{i_{La}(x) - i_{pa}(x)u_{\_pa}\} \qquad (10)$$

Also the dynamic load power parts of other two phases (b, c) are figured from RZALMS approach. The reactive load power current segment from the load current at x^{th}test for phase 'a' is registered as

$$i_{qa}(x) = i_{qa}(x-1) + \mu u_{\_qa} e_{qa} - \frac{\sigma \sin\left(i_{qa}(x-1)\right)}{1+\Psi\left|i_{qa}(x-1)\right|} \qquad (13)$$

$$e_{qa}(x) = \{i_{La}(x) - i_{qa}(x)u_{\_qa}\} \qquad (14)$$

Similarly reactive load power current components of other two phases (b, c) are also achieved using the same approach. The values of μ, σ and ψ are selected as 0.015, 0.0005 and 10, respectively. The equivalent per phase of load active power current component is derived as,

$$I_{pavg} = \frac{i_{pa} + i_{pb} + i_{pc}}{3} \qquad (15)$$

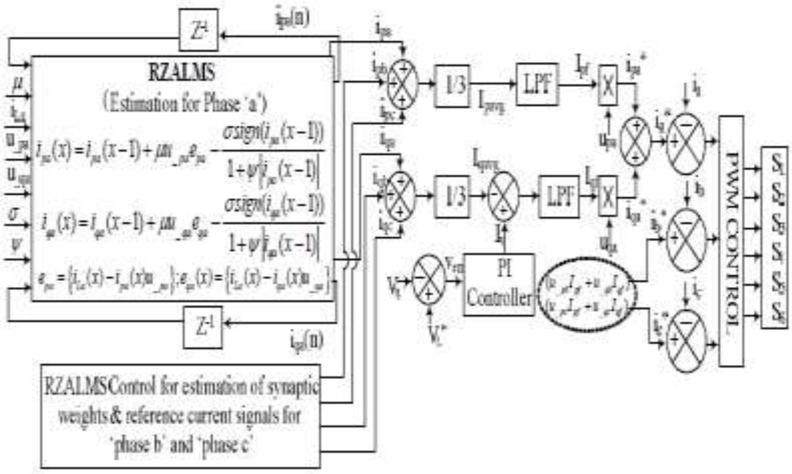


Fig2. Microgrid control approach

After passing through a LPF (Low Pass Filter), this component is expressed as active power current component of source current (i_{pf}). The equivalent per phase of reactive load power current component, is generated as,

$$I_{qavg} = \frac{i_{qa} + i_{qb} + i_{qc}}{3} \qquad (16)$$

To regulate PCC voltage, a PI (Proportional and Integral) voltage controller is used with the gain values ofk_p andk_i.The error between reference terminal voltage ($V^*{}_{\_t}$) and sensed PCC voltage ($V_{\_t}$) is fed to a PI controller, and itsoutput is estimated as,

$$I_{\_v}(x) = I_v(x-1) + k_p\{V_{\_err}(x) - V_{\_err}(x-1) + k_i V_{\_err}(x)\} \qquad (17)$$

Where$V_{_err}$is the voltage error and it is expressed as,

$$V_{\_err} = V_{\_t}^{*} - V_{\_t} \qquad (18)$$

The reactive component of source current is estimated as,

$$I_{qt} = I_{\_v} - I_{qavg} \qquad (19)$$

Extracting it from a LPF, it is said reactive power component,I_{qf}. The active and reactive power components of reference three phase source currents are calculated as,

$$i_{pa}^{*} = I_{pf}u_{\_pa} i_{pb}^{*} = I_{pf}u_{\_pb} i_{pc}^{*} = I_{pf}u_{\_pc} \qquad (20)$$

$$i_{qa}^{*} = I_{qf}u_{\_qa} i_{qb}^{*} = I_{qf}u_{\_qb} i_{qc}^{*} = I_{qf}u_{\_qc} \qquad (21)$$

The reference three phase source currents are estimated as,

$$i_a^{*} = i_{pa}^{*} + i_{qa}^{*} i_b^{*} = i_{pb}^{*} + i_{qb}^{*} i_c^{*} = i_{pc}^{*} + i_{qc}^{*} \qquad (22)$$

To generate PWM pulses for switching to three legs of VSI, these reference source currents (i_a^*,i_b^*, i_c^*) are compared with sensed three phase source currents (i_a, i_b, i_c).

IIII. controller using fuzzy logic

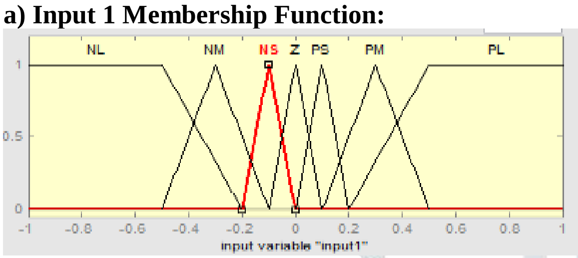
A fuzzy control framework is a control framework dependent on fuzzy logic—a scientific framework that investigates simple info esteems as far as sensible factors that take on constant qualities somewhere in the range of 0 and 1, as opposed to old style or advanced logic, which works on discrete estimations of either 1 or 0 (true or false, separately). Fuzzy logic is broadly utilized in machine control. The term 'fuzzy' alludes to the way that the logic included can manage ideas that can't be communicated as the 'true' or 'false' yet rather as partially true'. Albeit elective methodologies, for example, generic calculations and neural systems can perform similarly just as fuzzy logic much of the time, fuzzy logic has the preferred position that the answer for the issue can be thrown in wording that human administrators can see, so their experience can be utilized in the structure of the controller. This makes it simpler to motorize errands that are as of now effectively performed by people.

Fuzzy sets:

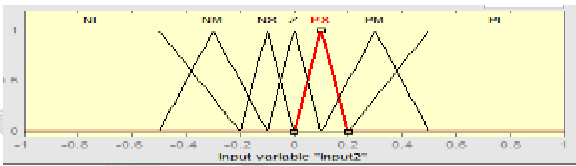
The information factors in a fuzzy control framework are all in all mapped by sets of enrollment capacities like this, known as fuzzy sets. The way toward changing over a fresh information incentive to a fuzzy worth is called 'fuzzification'.

The enrollment elements of the Fuzzy controller utilized in our reproduction model are given as pursues.

a) Input 1 Membership Function:



b) Input 2 Membership Function:



c) Output Membership Function:

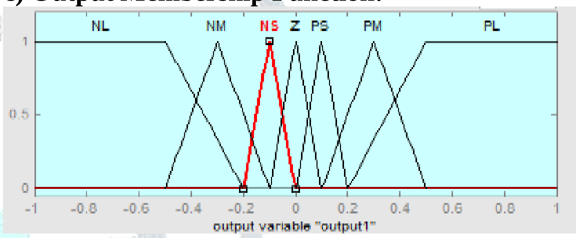


Fig 3 (a) Input 1 Membership Function, (b) Input 2 Membership Function, (c) Output Membership Function:

III. Simulation results

Simulated results of MG, are exhibited in this part. Consistent state and dynamic reactions of an inexhaustible based MG, are appeared and the conduct of moderate signs of control approach at load unbalancing, is portrayed in detail. The wind MPPT utilizing P&O approach is likewise included.

A. MPPT of Wind Power

The MPPT of wind age is accomplished through applying a P&O approach. It is appeared in Fig. 3 that at the wind speed variety, the PMBLDC generator current of phase 'a' is likewise decreased. In this way, the current at output of the DC-DC help converter is likewise diminished. The output voltage (V_0) over the DC bus capacitor is fixed. The extricated power after MPPT, is additionally diminished with wind speed changes.

B. Response of RZALMS Control Approach at Linear and Nonlinear Loads

The introduction of wind-hydro set up MG depends as for its control approach power. To display acceptable response of control approach, its diverse middle of the road signals are depicted in Fig. 4 at nonlinear burdens. The heap unbalance is made at t=1.3s, and the heap on that stage is recovered at t=1.4s. It is seen that at load unbalance, the heap current of stage 'a' (I_La) becomes zero and other two stage streams I_Lb,I_Lc moreover change their shape. Simultaneously unique and receptive burden power parts (i_pa,i_qa) furthermore become zero. The equivalent dynamic and receptive burden current sections (I_pavg, I_qavg) are furthermore diminished as the total burden request is reduced as a result of the nonappearance of burden on stage 'a'. The current part coming from a PI controller (I_v) and the responsive source power current sections (I_fq) moreover change with the heap assortment. The dynamic source power current part (I_fp) is consistent as central player power is fixed and reference source streams are sinusoidal and changed. The momentary indications of the control approach, are changing rapidly to achieve the steady state condition inside couple of cycles.

C. Dynamic Behavior of Wind-Hydro Based MG

The dynamic introduction of wind-hydro based MG under different circumstances is sketched out in Fig.5 at nonlinear weight. At t=1.4s, the breeze speed is extended, moreover the breeze power (P_wind) is also extended. The heap revenue (P_L) and hydro age (P_hy), are fixed, along these lines, extended limitless power is taken care of into the battery bank with respect to battery power (P_bt) and battery charging current (I_bt).During load lopsided condition, when the heap on stage 'a' is distant at t=1.5 s, the PCC voltages (V_abc) are kept sinusoidal and consistent and source streams (I_abc) of MG furthermore remain sinusoidal. The reimbursing streams of VSI (I_Ca, I_Cb,I_Cc) change their characteristics to compensate responsive force interest to keep up balance in voltages and streams at PCC and to shed sounds. The terminal voltage (V_t) is kept up steady at reference regard (V_t^*) all through the action. At t= 1.7s, the heap (I_LabcandP_L) is extended suddenly. With reliable breeze and hydro age, the battery underpins the framework and deliveries. This shows that during potential outcomes, the MG gives great response.

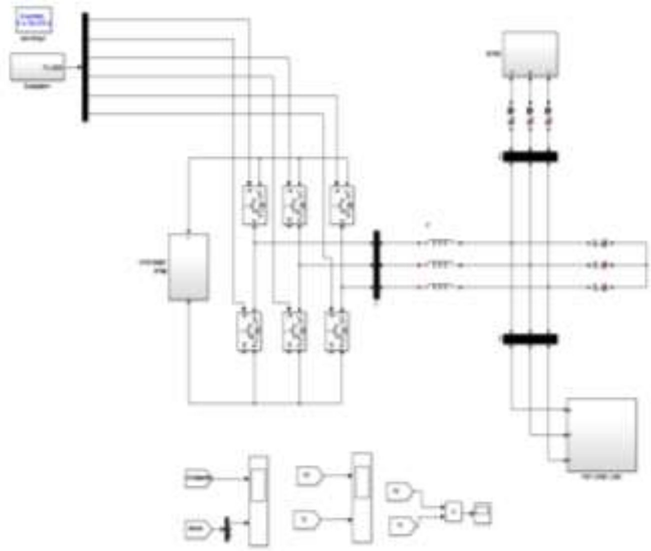


Fig4. Simulation diagram microgrid

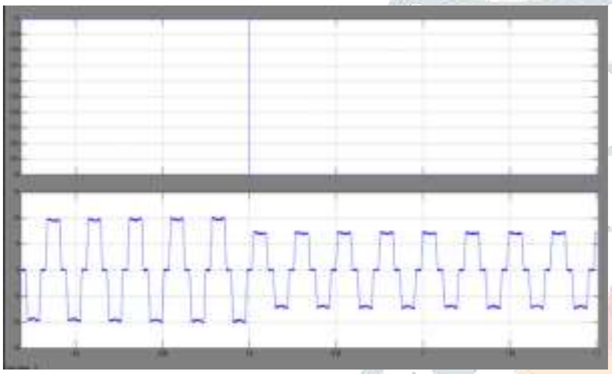


Fig5. P&O approach based maximum power tracking (a)V_w $(b)i_{pmbldc}$

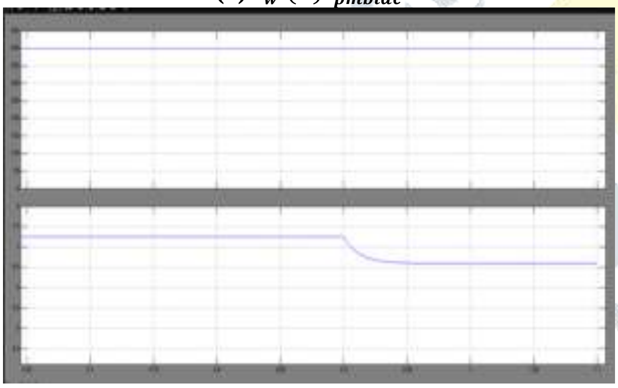


Fig6. maximum power tracking based on P&O approach$(a)I_0$ $(b)V_0$

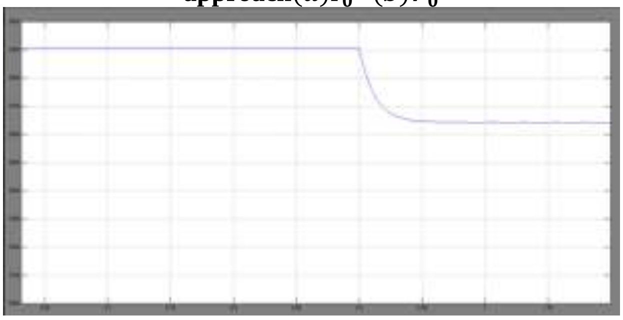


fig7. maximum power tracking based on P&$O\ approach$ $(a)P_0$

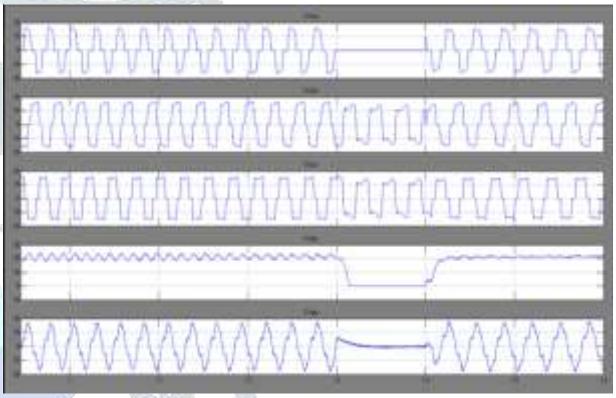


fig8. Intermediate signals of RZALMS control algorithm at nonlinear load $(a)I_{La}(b)I_{Lb}(c)I_{Lc}(d)I_{Pa}$ $(e)I_{qa}$

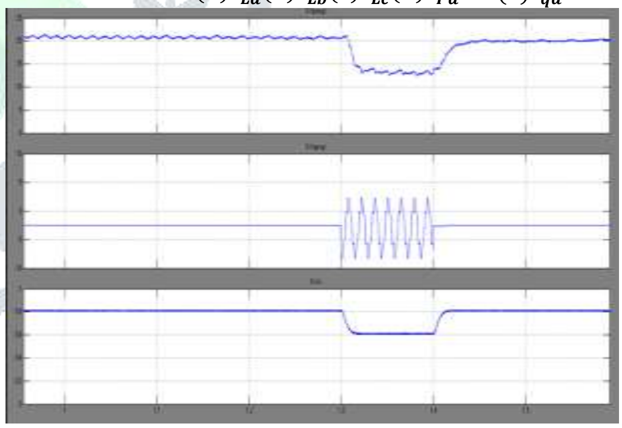


fig9 . Intermediate signals of RZALMS control algorithm at nonlinear load $(a)I_{Pavg}(b)I_{qav}(c)I_v$

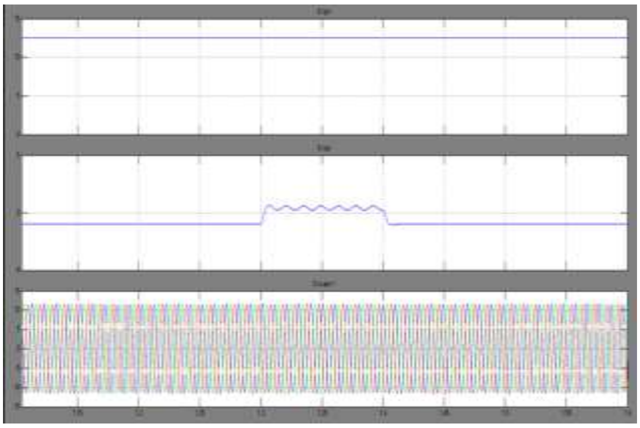


Fig10. Intermediate signals of RZALMS control algorithm at nonlinear load $(a) I_{Pf} (b) I_{qf} (c) i^*_{abc}$

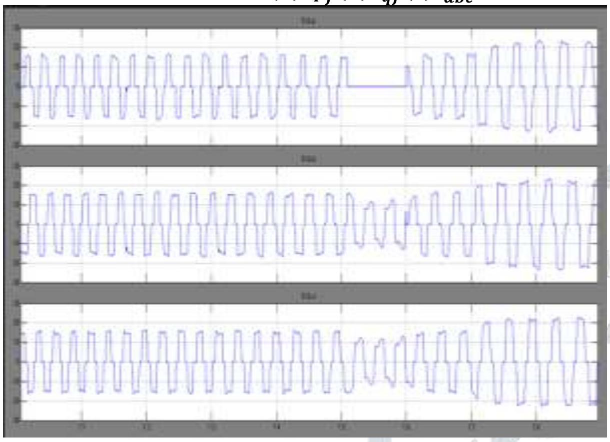


fig11. Dynamic condition Performance of MG at nonlinear load$(a) I_{La} (b) I_{Lb} (c) I_{Lc}$

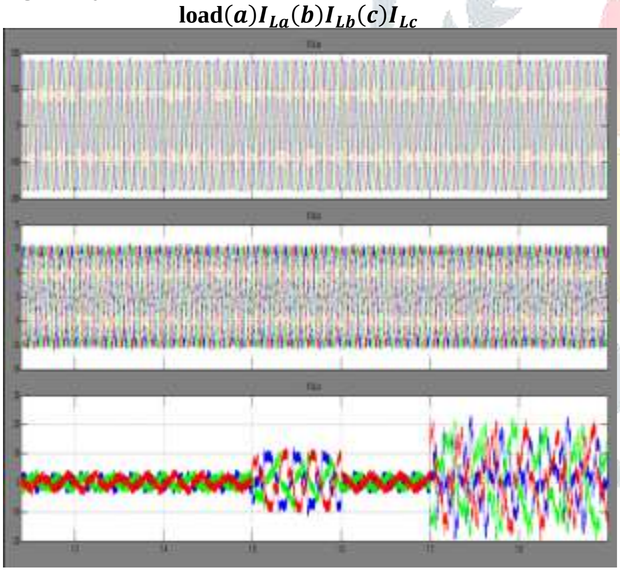


fig12. Dynamic condition Performance of MG at nonlinear load load$(a) V_{abc} (b) I_{abc}\ (c) I_{Cabc}$

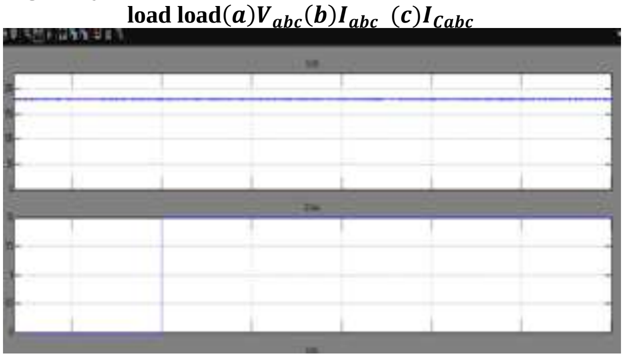


Fig13. Dynamic condition Performance of MG at nonlinear load$(a) V_t (b) V_w$

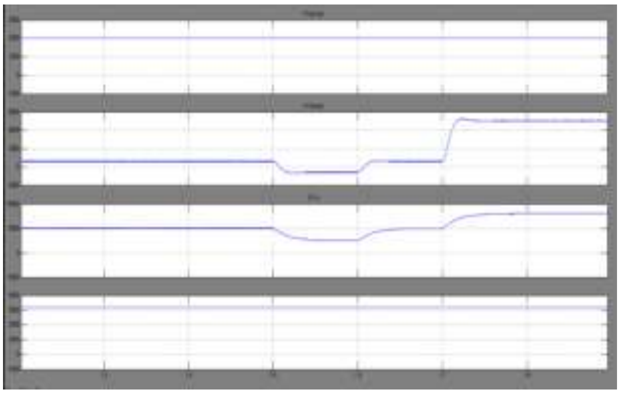


fig14. Dynamic condition Performance of MG at nonlinear load $(a) P_{Hy} (b) P_L (c) P_{vsc} (d) P_{wind}$

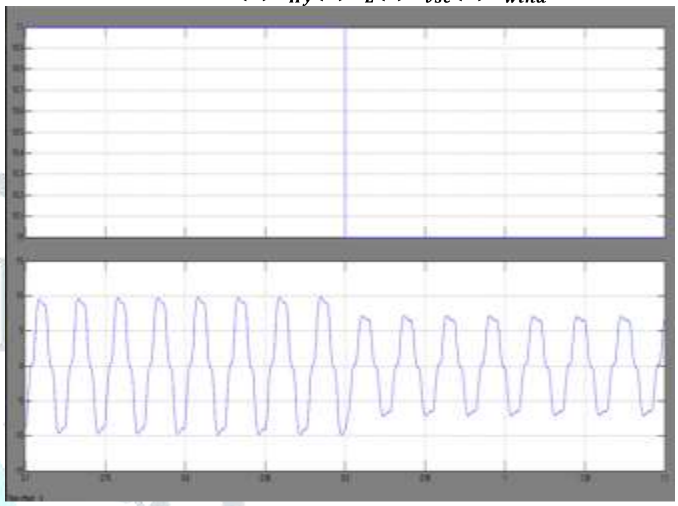


Fig15. maximum power tracking based on P&O approach With Fuzzy Logic Controller(a) V_w $(b) i_{pmbldc}$

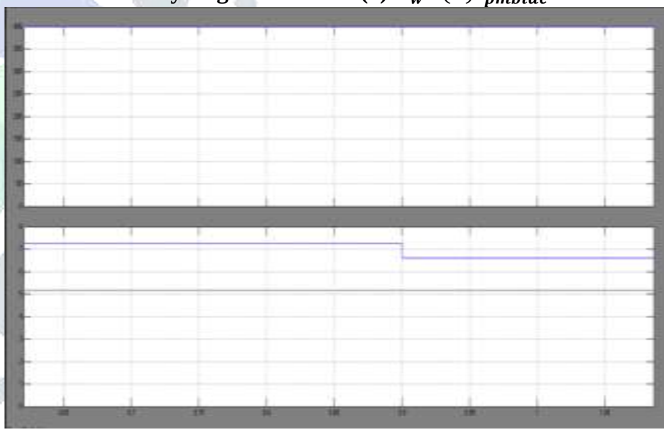


Fig16. maximum power tracking based on P&O approach With Fuzzy Logic Controller $(a) I_0\ (b) V_0$

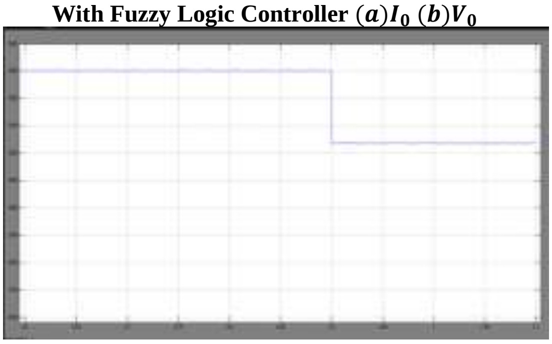


Fig17. maximum power tracking based on P&O approach With Fuzzy Logic Controller$(a) P_0$

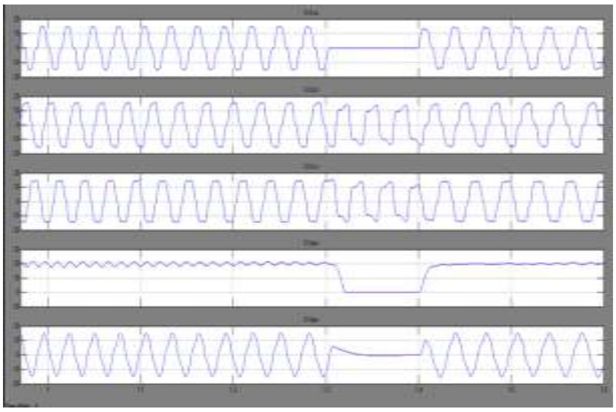


Fig18. Intermediate signals of RZALMS control algorithm at nonlinear load With Fuzzy Logic Controller $(a) I_{La} (b) I_{Lb} (c) I_{Lc} (d) I_{Pa}$ $(e) I_{qa}$

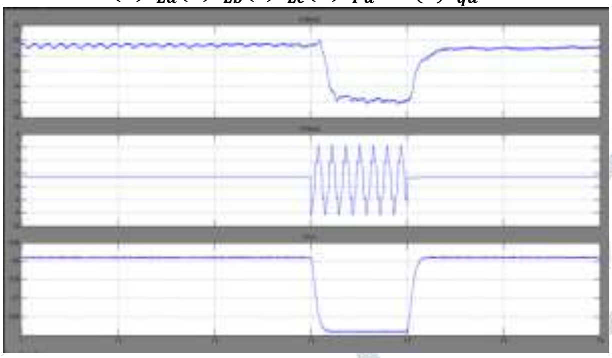


Fig19. Intermediate signals of RZALMS control algorithm at nonlinear load With Fuzzy Logic Controller$(a) I_{Pavg} (b) I_{qav} (c) I_{v}$

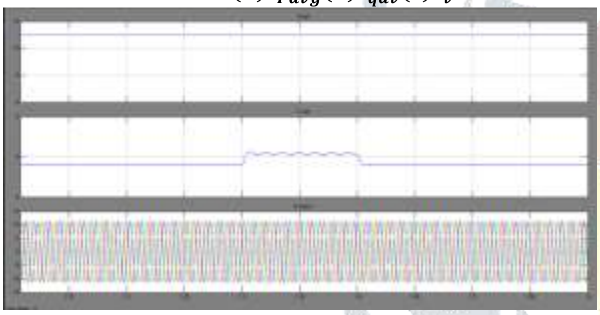


Fig20. Intermediate signals of RZALMS control algorithm at nonlinear load with fuzzy controller $(a) I_{Pf} (b) I_{qf} (c) i^{*}_{abc}$

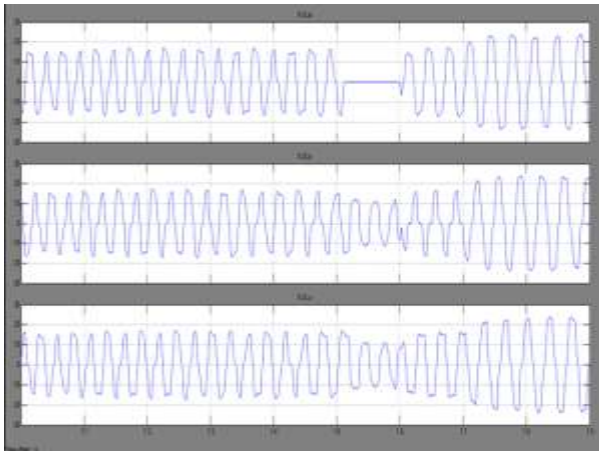


Fig21.Dynamic condition at nonlinear load With Fuzzy Logic Controller $(a) I_{La} (b) I_{Lb} (c) I_{Lc}$

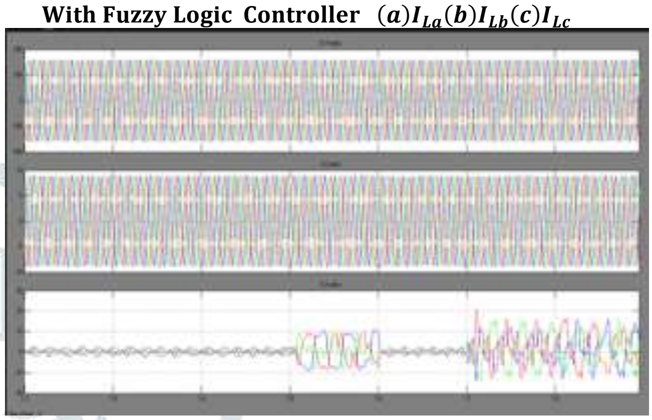


Fig22. Dynamic condition at nonlinear load with fuzzy controller $(a) V_{abc} (b) I_{abc}$ $(c) I_{Cabc}$

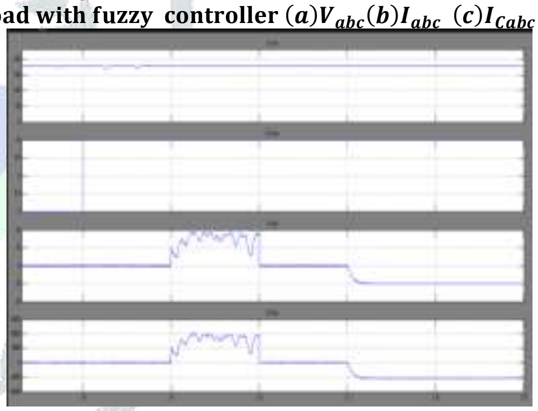


Fig23.Dynamic condition at nonlinear load with fuzzy controller $(a) P_{Hy} (b) P_{L} (c) P_{vsc} (d) P_{wind}$

VI CONCLUSION

An endless wind hydro based microgrid has been made. The presentation of MG has been show utilizing RZALMS control way to deal with oversee give power quality designs for example, suppression of harmonics, reactive power compensation, load changing and voltage control. It has likewise dealt with the force balance in the microgrid during different states, for example, high wind power age, load unbalancing and top burden interest. Such MG give energy self-administration in typical spaces and contributes in reducing the fossil utilize and its unpleasant effect on the atmosphere. A particular voltage source inverter has performed power quality improvement and force evolving. The PMBLDCG needn't waste time with speed sensor, position sensor and wind speed sensor for MPPT control. Singular inverters and converters are not being utilized on different units viz. wind, hydro, battery bank, and so forth consequently.

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