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ADAPTIVE NONLINEAR SLIDING MODE CONTROL METHOD BASED OPTIMIZATION OF SOLAR AND WIND POWER GRID CONNECTED SYSTEM

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ABSTRACT*: This work deals with Optimization in a combined power system with Solar cell subsystem, Wind turbine driven induction generator sub system and Diesel Generator set these sub-systems used in tandem and with battery backup can ensure continuous power supply. Solar cells will have the limitation of power generation during day time only while the wind turbine driven IG to a local community will have fluctuations in power generation due to variation in wind velocity. The combination could provide continuous power supply to consumers living in remote localities like villages in hill tops where grid supply may not exist. Electric power generation through wind turbine driven Induction Generators requires reactive current for the machine excitation. In case of non-availability of grid supply, Permanent Magnet Synchronous Generator is the alternative and hence incorporated in the present research work. The power electronic scheme proposed herein involves a novel choice of power source inverter for obtaining a constant voltage and constant frequency AC power supply for utility / commercial applications. Anembedded controller is employed to produce firing pulses for power converters in a way that the combined output from the Induction Generator, Solar Cell system and diesel generator set.*

Key words: Optimization, Solar, Wind, Permanent Magnet Synchronous Generator, Induction Generator

I. INTRODUCTION

Currently, one of the proposed technological solutions for isolated sites electrification, and therefore solve the problems of using classical techniques to ensure a power grid extension, as well as the environmental and economic disadvantages of using fossil energy sources, we find the use of so called hybrid energy production systems, which combines renewable energy sources such as solar and wind, which allows ensuring the supply security and autonomy in energy whatever the weather conditions, what has a considerable advantage compared to other systems based on a single energy source [1]. With the aim of a better exploitation of these hybrid systems, using an MPPT controller is required to operate both PV and Wind sources in their maximum power point (MPP) at any time and regardless of the climatic conditions [2], which improves their energy performance and consequently optimizes the performance of PV/Wind complete system.

The main objective is to study the modeling, control and optimization of a hybrid energy system for isolated and remote sites, system includes a PV generator, a permanent magnet synchronous generator (PMSG), a storage system (batteries) and the assembly supplies a dc electrical load. as well as proposing new MPPT approaches for both PV and Wind systems, and developing an intelligent energy management strategy of the full hybrid system. In this work, we present a part of our study which consists, on the one hand, the modeling and the simulation of a hybrid energy system combines two energy production chains; a PV system

[3,4] that consists of a photovoltaic generator and a dc/dc booster converter, a Wind system [5,6] consists of a wind turbine, a PMSG generator, a ac/dc rectifier and a dc/dc boost converter. And on the other hand, optimize and improve the proposed system performance, by developing a robust MPPT controller based on the nonlinear sliding mode control [7].

II. LITERATURE SURVEY

Some MPPT methods [8,9], such as constant voltage tracking (CVT), incremental conductance (INC) method, intelligent method, and particle swarm optimization, are developed to track the MPPT to increase the efficiency of the PV inverter. Intelligent methods are utilized to control the PV inverter and active power filter [10, 11]. Some scholars have employed sliding mode control (SMC) to control the PV grid-connected inverter. A novel robust adaptive sliding-mode controller for a grid-connected PV inverter was proposed in Reference [12]. Backstopping sliding control and fuzzy sliding control were investigated in References [13] to improve the performance of PV inverters and dynamic systems.

An adaptive fuzzy controller and a neural network controller have been developed for a PV grid-connected inverter in References [14]. Motivated by the above discussion, an adaptive intelligent sliding control is proposed for a PV inverter, and an MPPT algorithm is presented by using an INC method with an adaptive step size. In literature [5-6] two techniques are discussed, one is Genetic Algorithm and the other is Particle Swarm Optimization. These two techniques are used to track the MPP in partial shadow condition and then a comparison is made between both the techniques. Sliding mode control [7-9], on the other hand is one of the most effective robust control techniques for nonlinear and discontinuous systems due to its simplicity, stability, higher flexibility in design procedure and great performance. Due its advantages SMC has found applications in various fields such as robotics, motor control [10] and converter output control [11-12].

Flyback converter can be used with different DC link capacitor configurations. First configuration is DC link capacitors in between the DC-DC flyback converter which can boost the DC voltage to the levels compatible with the grid voltage and an inverter. But this configuration creates problem in maintaining the efficiency at high frequency [13-14]. In these mentioned literature, SMC is used to track the MPP from a PV panel which can drive a flyback converter. This paper approaches a simple method of extracting maximum power from a PV system using Nonlinear SMC which drives a flyback converter and then inverting the voltage for grid connected operation.

III. PROPOSED SYSTEM

This paper presents an integrated traction machine and converter topology that has bidirectional power flow capability between an electric vehicle and the dc or ac supply or grid. The inductances of the traction motor windings are used for bidirectional converter operation to transfer power eliminating the need for extra inductors for the charging and vehicle-to-grid converter operations.

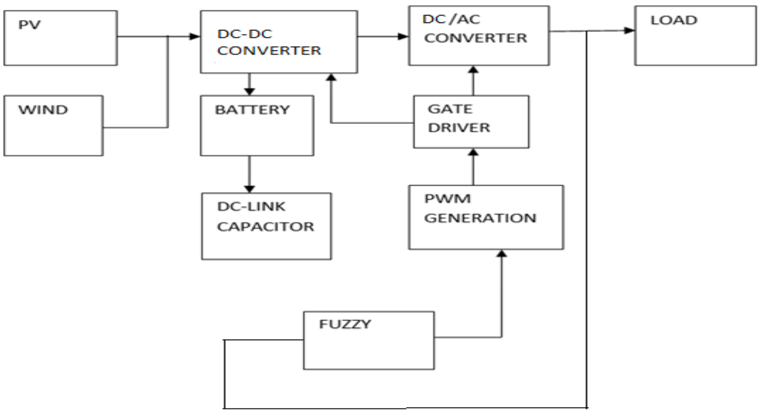

Figure: 1 proposed block diagram

The block Diagram of Proposed system is shown in Figure 1. These operations are in addition to the vehicle traction mode operation. The electric power train system (Domestic Application) size and weight can be minimized with this approach. The concept has been analyzed with finite-element coupled simulation with dynamic analysis software. Experimental results are also provided with electric machines. The interleaving technique has been used with the inductors to share the current and reduce the converter switching stresses.

3.1 Solar PV array module

A photovoltaic module includes various cells related to serial and parallel association with giving the essential output power. In, by and large, a PV structure shows a nonlinear current-voltage operator. The photovoltaic conditions for demonstrating signs have made. A checked commendable of a silicon photovoltaic model showed. The yield centrality of each PV structure at time t can be secured from the sun radiation utilizing the progressively with a condition.

$$\sigma PV(t) = I(t) \times Ax \square PV \quad (1)$$

Where I - Photovoltaic sun beams radiation

A - Photovoltaic district and

□PV - Entire appearance

of the photovoltaic and a DC-DC support convert

It expects that the photovoltaic framework has a most extreme power point following frame. On the off chance that the amount of photovoltaic structures has NPV, the general power made is PPV (t) = NPV × PPV (t). The eventual outcomes of the temperature in the PV board disregarded.

3.2 Wind generation model

The energy of the wind turbine depends upon the speed revolution, broadcasting wind current and the scope of the wind, for logical model has conveyed in the going with conditions.

$$W = \begin{cases} 0 & U\partial \\ \frac{1}{2}.\rho.\pi.P^2 & U^3, \quad V_d \leq V \propto \\ Qn.Vin \leq U \propto & \end{cases} \tag{2}$$

Where w is the power, U is the speed, U_d is the boot speed V_{in} is the assessed speed, ∂ is the wind current, P is the most remote purpose of the rotor and P_n is the apparent power. Toward the end when the wind speed accomplishes beyond what many would consider possible, the wind turbine beginning. At the point when the wind power generation execute the edge speed of the windmill, it produces steady yield power. In case the WT speed gives the cut-off respect, and the wind power generator stops to secure the generator. The statement of the yield of each Power Wind Turbine (PWT) has analogized with the wind speed by the going with Equation (3).

$$w = \begin{cases} 0V(t) \leq V_{cut} - in \ or & V(t) \geq Vcut - Vin \\ \Pr \frac{(v(t) - Vcut - in)}{vr - Vcut - in} & Vcut_{in} < V(t) < vr \\ \Pr & Vr < V(t) < vcut - out \end{cases} \tag{3}$$

Where

V - Wind speed

P_r - power of WT

V_r, Vin, $Vcut_{out}$ - Speed of the wind turbine

Vwind -quantity of wind turbine

the general power delivered as PWT (t) – NWind – PWT (t)

3.3DC to DC boost converter

A DC-DC converter circuit diagram as showed up in Figure 2. It has a bi-directional operation depending upon the power flow, where it fills in as an inverter to trade the energy from source to grid, and as a rectifier. At the point when this circumstance the battery was charged utilizing DG. The converter has shown in light of its assessed point of confinement and profitability, which are believed to be relentless every single through it working degree. Additionally, its assessed DC voltage decides the amount of PV modules and batteries in each string of the hybrid framework display and the battery bank, independently. The schematic plan of the DC-DC help converter has given as

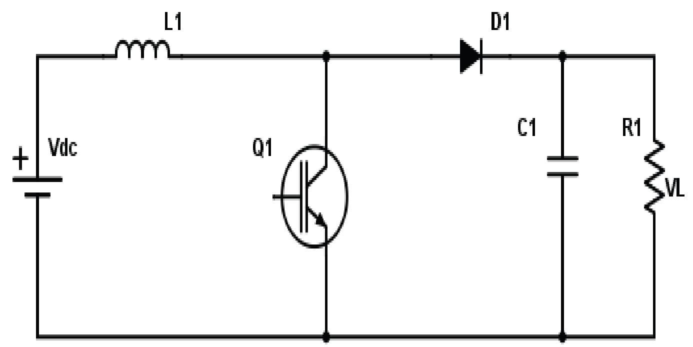

Figure 2 DC-DC Boost Converter

The general outline conditions of the boost converter are given below $VL = \frac{Vs}{1+\sigma}$ (4)

Where

VL	-	Output voltage
Vs	-	Input voltage
σ	-	Clock pulse

The base inductance required for operation in continuous conduction mode (CCM) is L_{min}, and it is expected to be higher, σ is the commitment cycle, RL is the stack assurance, and fs is the switching frequency of the MOSFET.

$$L_{\min} = ((1-\sigma)^2)\sigma Rl)2f_s \tag{5}$$

The capacitor regard has made with the ultimate objective that the voltage swell must be minimum. The regard capacitance has given for the voltage swell V_r as

$$C_{\min}\sigma / Rlf_s V_r \tag{6}$$

The output voltage relies on the estimation of the duty cycle which is in charge of the consistent output voltage. The load current I0 is additionally subject to the duty cycle, and it is given by

$$I_0 = (1-\sigma)l_s \tag{7}$$

Where I_s is the source current. The modification in the current ∇I as a result of the estimation of inductance is given as

$$\nabla I = \frac{V_s(V_l - V_s)}{f_s L V_l} \tag{8}$$

3.4 Loss of Power Supply Probability

At the point when the power generation frame hybrid assets isnot sufficient to keep up load demand the loss of power supply probability will happen. The degree of total hours that demand energy result when the HRES isn't set up to supply the weight with the whole amounts of hours is known as Lost Power Supply Probability (LPSP). The going with condition can describe the LPSP.

$$LPSP = \frac{\sum_{t=0}^{T} Time(HRSS_{available}(t)P_{need}(t))}{T} \quad (9)$$

Where

HRSS = Hybrid renewable sources

P_{need} = Load Demand

The optimization make the degree parts of the disconnected power system just satisfies the load conditions with a satisfactory estimation of LPSP.

3.4 Loss of Load Probability

The general probability energy will be lacking is known as the Loss of Load Probability (LOLP) which imparted concerning days consistently, hours consistently or level of the time. The LOLP addressed by the going with course of action of conditions.

$$LOLP = \sum_{i=1}^{n} hours\left(Isupply < \frac{Imethod(t)}{n} \right) \quad (10)$$

Where

$$\text{Imethod}(t) = \frac{L(t) - Pw(t) - P_{pv}(t)}{Vl} h(Ibattery(t)) \quad (11)$$

$$\text{Imethod}(t) = \min\left(\text{I}\max = \frac{0.2soc}{\Delta t}, soc(t)\sigma - \frac{soc\min}{\Delta t} \right) \quad (12)$$

Also,

Imethod - Required Current at hour t

Isupply (t) - Current given to power resource

n - Few specimens

Vl - Voltage requirement

Lt	-	Electrical load requirement at hour (t)
pwt	-	Power created the wind at hour (t)
P_{pvt}	-	Power generation of solar at hour (t)

If LOLP is low, by then it realizes the high cost of the structure and a different way.

V. SIMULATION RESULTS AND DISCUSSION

This paper presents an integrated traction machine and converter topology that has bidirectional power flow capability between an electric vehicle and the dc or ac supply or grid. The inductances of the traction motor windings are used for bidirectional converter operation to transfer power eliminating the need for extra inductors for the charging and vehicle-to-grid converter operations. These operations are in addition to the vehicle traction mode operation. The electric power train system size and weight can be minimized with this approach. The concept has been analyzed with finite-element coupled simulation with dynamic analysis software. Experimental results are also provided with electric machines. The interleaving technique has been used with the inductors to share the current and reduce the converter switching stresses**.**The Simulink diagram of proposed system is shown in Figure 3.

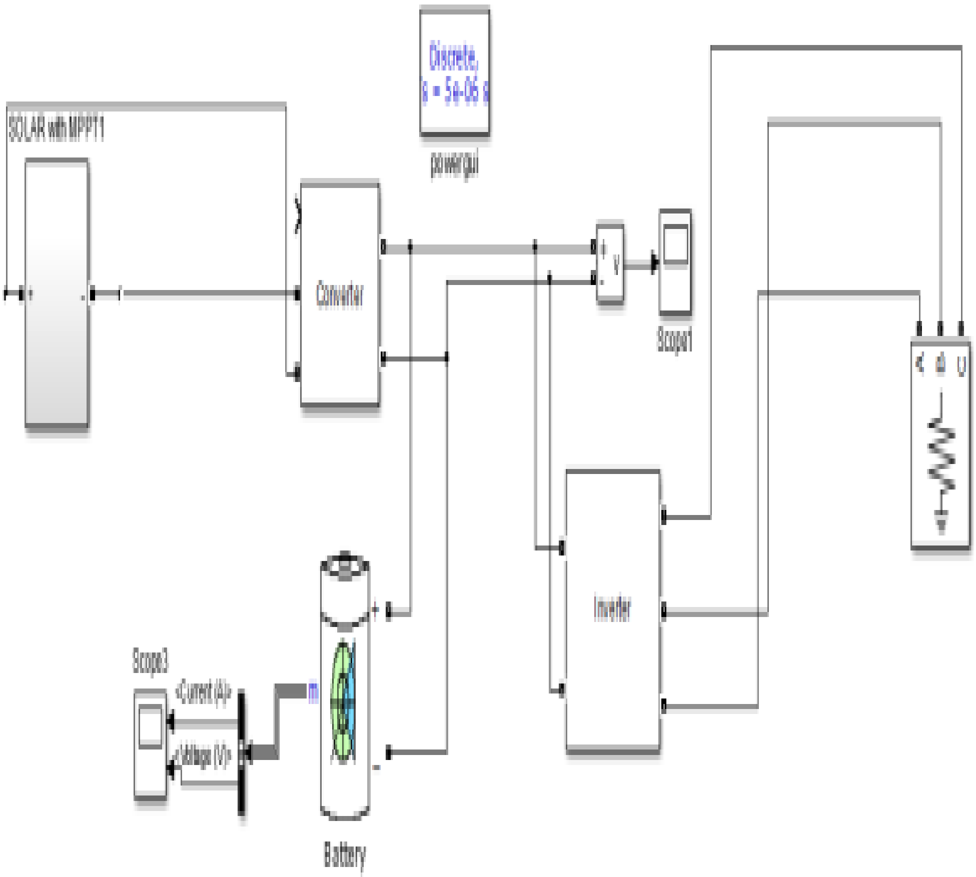

Figure 3. Simulink Model

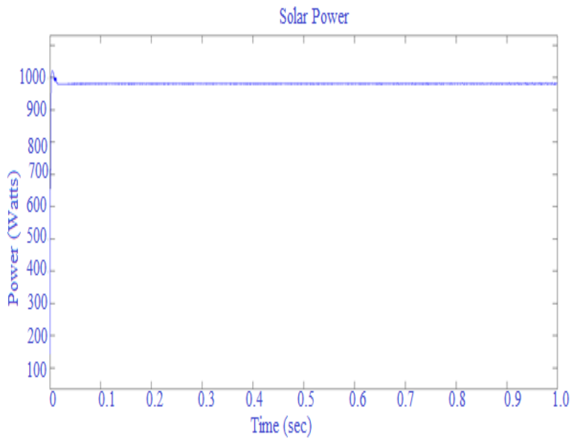

Figure 4 Simulation results of PV power

Figure 4 describes the solar power generation which is produced the power up to 1050 watts with respect to time t= 1sec.

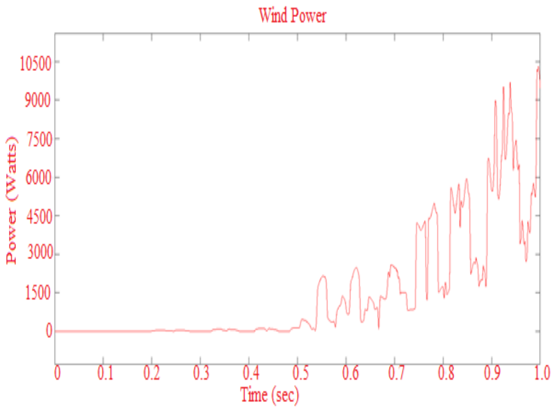

Figure 5 Simulation results of Wind power

Figure 5 shows that the energy production for wind model with the maximum energy of the gain voltage: 9750W with respect to time t=1 sec.

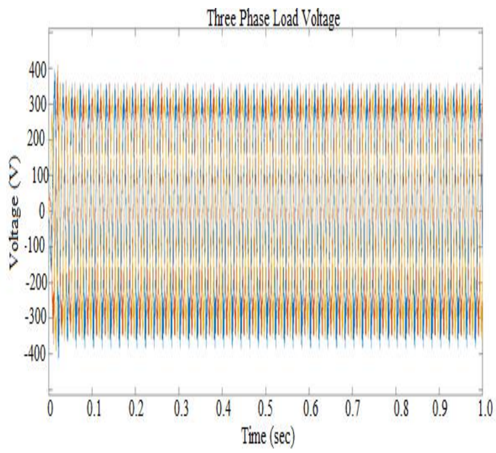

Figure.6 Load Voltage

The above figure 6 shows the three phase Load voltage is investigated to confirm the performance of the solar/wind energy system under the proposed Nonlinear Sliding Mode controller. According to figure 6, the solar/wind energy system can produce the required voltage components for different phases rapidly and help to maintain a constant load voltage.

V. CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

We have proposed a model for operation planning purposes in ERS including RE and hybrid (ultra capacitors and batteries) ESSs integration. At the same time, we have considered regenerative braking capabilities of trains, with the aim to analyze the renewable generation impact, the behavior of HESSs and energy and economic savings in ERSs. Results from a realistic case study of a high speed ERS in Spain show that the integration of RES along with HESS can achieve an improvement in costs and energy savings of 33.22% and 9.63%, respectively. It has also been shown that the HESS properly complements and can be beneficial for both train regenerative braking and complement the intermittent production from renewable sources.

5.2 FUTURE SCOPE

The Solar PV System and Wind Energy System are implemented autonomously. In Solar PV system, a modified incremental conductance algorithm is employed for MPPT.In Wind Energy System, the Voltage and Frequency in line side is regulated by applying Stator Flux Oriented Control for a back to back converter. The hybrid working of Wind Energy System and Solar PV system will be taken as a future work. Along with this, the concept of charging or discharging the battery based on the availability of wind and solar energy will be implemented.

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