Switched Capacitor Based Motor Drive Application Using Sazz Converter

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Abstract- *An investigation into the design of intelligent maximum power point tracking controller for a solar photovoltaic system at maximum power output for varying levels of temperature and solar irradiation is presented. The Photovoltaic system comprises a solar PV module, DC-DC boost converter, Inverter and induction motor as a load. The thesis attentions on the IM motor is associated with a PV module through a Maximum Power Point Tracking (MPPT) controller. From various MPPT methods previously proposed, perturb and observe (P&O) technique is established because of its ease implementation and low cost. An improved MPPT algorithm is explored which uses Genetic Algorithm assisted Neural Network to better trajectory maximum peak power point. The IM motor controller senses the rotor position by using Hall Effect sensors to generate corresponding control signals for three phase AC powered inverter switches and to provide optimized electrical power to the IM motor. A simple Proportional Integral controller is implemented for speed control. For establishing the expansive suitability of the system, it is of prime importance to match the supply and loads with the different phases of the day.*

Keywords- induction motor, Maximum Power Point Tracking, Hall Effect sensor

I. INTRODUCTION

The energy constraint of the world is ever growing. The increasing energy demands put a compression on the conventional energy sources like oil, gas and coal. The intake of fossil fuels also has an environmental effect; it is deliberated the main reason of weather change due to their polluting effects. The energy consumption is employed by a release of carbon oxide (CO2) into the atmosphere and it gives for more than of 60% of the worldwide CO2 emitted in the atmosphere each and every year (Greenwood 2009). The energy sources on the basis of fossil fuel, are however limited in extent. They are hence equally as much the prompting factors of the pollution of the environment, ensuring the limited extent of the sources of energy such as fossil fuel. Excessive dependence on oil, unsteady energy prices, adverse of air quality, high level of financial risk and uncertainty are other factors, frightening the use of conventional energy sources. Standalone applications of PV energy are quite predominant. PV electricity has the maximum applicable utilities in areas like water pumping, domestic appliances, fans, enhancing usage of electricity in rural locations where the unavailability of grid connection, air conditioning, etc. is yet to be implemented. However, in many poor, arid and rural areas is placed too far away from the existing grid lines. Installation of new transformers, long transmission lines and other protection devices is very expensive. Windmill and Internal Combustion engines have been installed in such areas. These systems have some disadvantages, such as the lack of proper maintenance and age factor in windmill and in IC engines refueling and transporting that fuel to remote villages is somewhat difficult because there is not availability of proper roads or supporting structures in most of the rural areas.

This research work deals with MPPT controller being incorporated into a solar Photovoltaic system supplying a Brushless DC motor drive as the load. The MPPT controller makes use of a Genetic Assisted Radial Basis Function Neural Network based technique that includes a high step up Interleaved DC-DC converter. The solar Photovoltaic system uses Genetic Assisted–Radial Basis Function–Neural Network (GA-RBF-NN) where the output signal governs the SAZZ boost converters to accomplish the MPPT. The main objective of the research is, to identify the best value of Maximum Peak Power Point of solar photo voltaic system with faster response time. to reduce the voltage stress by using of interleaved SAZZ converter and this converter is characterized by a low input current ripple and hence it provides the reduction of current stress. These advantages make this converter, very attractive in the renewable energy sources like Solar PV systems.

The converter topology is based on that of the dual interleaved boost converter with interphase transformer [2, 13-15] and benefits input and output ripple currents that are at twice the switching device frequency. The topology is shown in Fig. 1 where an auxiliary switch and diode are added to each switching leg, along with snubber capacitors, CS1 and

CS2, in parallel with the main switching devices Q1-Q4. The snubber capacitors may be partly or entirely formed by the output capacitance of the main devices, Q1-Q4. The simple auxiliary circuits utilize a single small inductor, L1, connected to the input which forms part of the total input inductance. By turning on the auxiliary device immediately before the main switch, ZVZCS turn on of the main switch can be achieved along with zero current (ZCS) turn on of the auxiliary device. Both devices are ideally turned off simultaneously with ZVS and ZCS for the main switch and auxiliary device respectively. This topology offers the soft switching benefits of the SAZZ converter topology but with a reduced number of devices per leg. There is a single input auxiliary inductor operating at twice the switching frequency and the potential exists for integrating the main and auxiliary inductors.

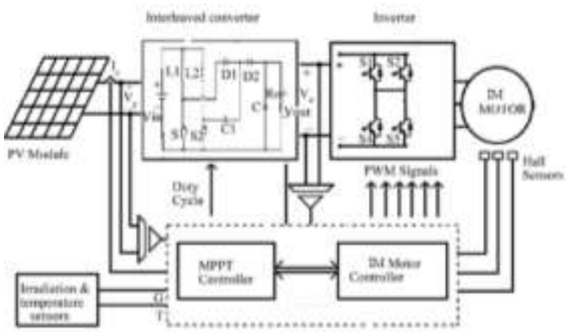

Figure 1 Block diagram of the proposed stand-alone Solar PV system

The remainder of this dissertation is organized in the following fashion: In Chapter 2, a review of the published work on existing work is presented. Chapter 3, describes the proposed system design in detail. Chapter 4 the results were compared and the performance of the model and the technique were discussed. In Chapter 5, summarizes the main contributions of the research.

II. LITERATURE REVIEW

Wang et al. (2011) presented "A dual-mode controller for the boost PFC converter". The dual mode controller is used to increasing the power flow and also controls the input current. In continuous mode the controller produce the high efficiency in light load condition and improve the power. This control method has combines the operation of continuous current and critical current mode is used. Accordingly, the dual-mode control scheme of the boost PFC is suitable for a fixed-frequency boost PFC controller application, and the dual-mode control circuit is simple and easy to build into an integrated circuit without additional cost and space. Mallik et al. (2017) presented "Input Voltage Sensorless Duty Compensation Control for a Three-Phase Boost PFC Converter". The three phase boost converter was used in the PI 26 based control method for reducing the ripple and to improve the power factor and thesystem efficiency is high.

Siva (2015) presented "MPPT for Photovoltaic system using SEPIC converter for high efficiency". The MPPT based SEPIC converter for increasing the efficiency. The solar is greatly used today because easily available generation, utilization cost is less and less maintenance. Incremental conductance is used to extract the maximum power from the PV source. This MPPT method has high tracking ability and widely used. This results in high accuracy, less oscillation at the output power. The SEPIC converter has two inductor, switch and diode. The coupling capacitor is used for reaching the zero voltage soft switching of switch and diode. This converter is used to regulate the voltage by changing the time pulse. The frequency and duty ratio is utilized for reducing the magnetic component and the proposed converter has reduces the voltage stress.

Jiao and Luo (2010) presented "Quasi sliding mode controller for single phase PFC boost converter". The sliding mode controller to regulate the current and PI is used to regulate the output voltage and neglect the use of differentiator. The ratio of switching frequency to line frequency is less the linear current control is inadequate. The cross over frequency is limited for increasing the system stability. The sliding mode control is nonlinear method used for power converter. The power factor is high under the various frequency and input voltage. The converter is designed to achieve the power factor is near to unity and to regulate the output voltage. The sliding mode controller is used to reduce the current distortion and fast response at the output of the system.

Wang and Khaligh (2015) presented Interleaved SEPIC PFC converter using coupled inductors in PEV battery charging applications. The interleaved based SEPIC converter has maximum efficiency, reduce the input current ripple, less total harmonic distortion and use less inductor component count. The coupled inductor can be shared in the DC voltage and magnetic core. This inductor is utilized for reducing the duty cycle mismatches and can solve the current sharing problems in the proposed SEPIC converter system. The input side of the converter reduces the inductor ripple and current is changed lower value compared to non coupled circuit method for decreasing the ripple and THD is small.

Bodetto et al. (2016) presented "Design of AC–DC PFC High-Order Converters With Regulated Output Current for Low-Power Applications". The AC-DC converter has used to regulate the voltage and lossless resistor behavior is achieved. In industrial application when large number of power electronic devices is used and the power factor issue is raised. The power factor is increased by using the control method. In low power application the switched mode AC-DC PFC are designed to ensure the high quality of power at the proposed circuit. The use of DC power is less than the sinusoidal peak and increases the voltage ratio. In SEPIC converter the EMI based filter is not used for increasing the efficiency. In sliding mode control , SEPIC converter the input side act as the pure resistor and the power is absorbed by using the resistor and it can be transferred to the output.

Singh and Singh (2010) presented "Voltage controlled PFC SEPIC converter fed PMBLDCM drive for an air-conditioner". The speed of PMBLDC motor is controlled by using the single ended primary inductor converter for power factor converter. In output side the harmonics are reduced by voltage control method. In single stage power conversion the converter has high reliability and less switching losses. The PFC control of DC link voltage and speed of the motor is sensed by the Hall Effect. The converter consists of voltage reference generator, rate limiter, voltage controller and PWM controller. The rate limiter is introduced for maintain the voltage error during transient period. The voltage controller uses the PI controller and tracks the error voltage and generates a control signal. The PWM process the current error between the reference input current and the dc current. This controller will amplify the error and produce the saw tooth carrier waveform and generate the switching pulse of the converter. Hui et al. (2010) presented "A hybrid wind-solar energy system: A new rectifier stage topology". The hybrid of solar and wind energy used for extracting the power and fed into the Cuk- SEPIC converter is used. When load demand arises the renewable energy is used to compensate the demand. The passive filter is used for reducing the high frequency harmonics. This harmonics will decrease the lifespan and leads to power loss. The hybrid converter can reduce the passive elements and increase the efficiency.

Arai et al. (2008) presented "Power electronics and its applications to renewable energy in Japan". The power electronic converter is widely used in industrial application because it can generate the voltage and current with regulated value. Chiu and Lin (2006) "A bidirectional DC-DC converter for fuel cell electric vehicle driving system". In proposed bidirectional converter has simple, high efficiency, and low cost. The dc-dc converter can draw the current from the battery and needed to boost the voltage for run the vehicle. The energy storage device is used to absorb the feedback power from the machine and the bidirectional converter is to boost the voltage upto the desired level.

III. SYSTEM DESIGN

In the proposed system, Maximum power point tracking is used in photovoltaic systems to make the maximum of the photovoltaic array output power, irrespective of the temperature and radiation conditions and of the load electrical characteristics. Thus the PV array output power is used to directly control using the DC/DC converter, thus reducing the complexity of the system. This MPPT method is based on use of an incremental conductance of the PV to govern an optimum operating current for the maximum output power. In this system PV array is used as an input source and SAZZ converter is used as an impedance matching network for getting maximum power. Incremental conductance method is used to find the optimum maximum power and it depends on the power tracked the SAZZ converter switches are turned on. Predictive control technique enhances the system gain and develops the transient response speed. A three phase inverter which is associated to Brushless DC Motor system that uses predictive control loop is successfully employed to run the load given to the motor. A BLDC motors are recommended for many low and medium power drive applications because of their high efficiency, high flux density per unit volume, low maintenance requirement, low electromagnetic interference (EMI) problems, high ruggedness and a wide range of speed control.

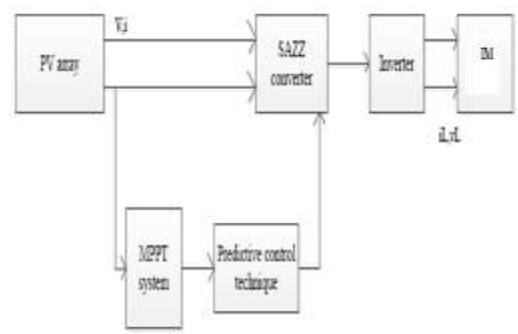

Figure 2 PV systems with SAZZ converter

The SAZZ converter is made especially for fuel sources Snubber is required to suppress the rate of rise of forward voltage across the power semiconductor devices (dv/dt). The snubber circuit is basically a series connected resistor and capacitor across the thyristor. Zero Voltage and Zero Current transient is associated with resonant circuits. Resonant power converters contain resonant L-C networks whose voltage and current waveforms vary sinusoidal during one or more sub intervals of each switching period. These sinusoidal variations are large in magnitude, and the small ripple approximation does not apply. The SAZZ converter normally has two switches when compared to other converters. It boost up the output DC voltage. This converter finds its application in electric vehicle. A DC- DC converter topology is presented combining the soft switching effects of the Snubber Assisted Zero Voltage and Zero Current Transition (SAZZ) topology and the increased inductor frequency of the dual interleaved boost converter with inter-phase transformer. The snubber capacitors and output capacitances of the main devices are discharged prior to turn-on using a single auxiliary inductor, eliminating turn-on losses. Furthermore, the turn-off losses are significantly reduced since the energy stored in the device output capacitance at turn off is recovered at turn on

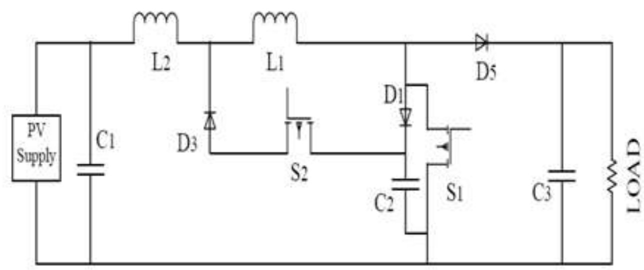

Figure 3 Circuit diagram of SAZZ Converter

IV. RESULT AND DISCUSSION

The MPPT for PV system is simulated in MATLAB. Incremental conductance and predictive control algorithm is implemented. By using MATLAB Simulink, the PV system with BLDC motor as load drive is designed.

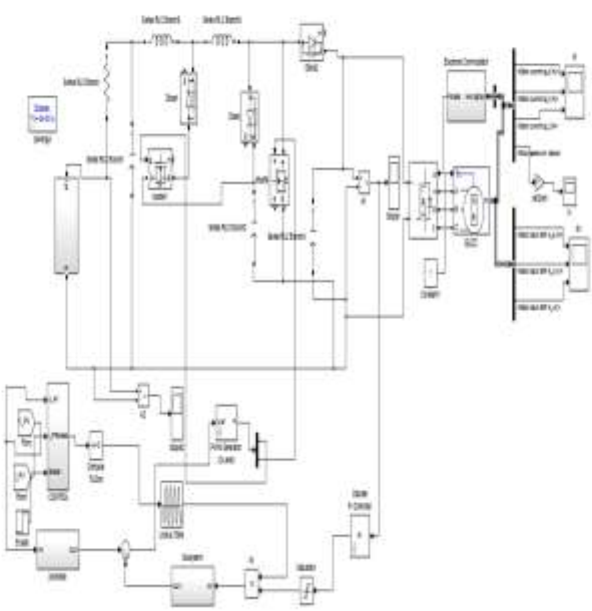

Figure 4 Simulation Model of proposed system

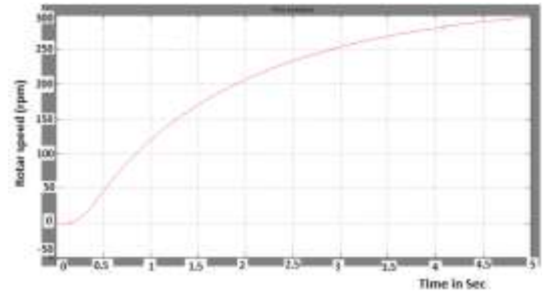

Figure.5 simulation results for speed of induction motor

The use of predictive control has reduced the switching time of the converter switches. The turn off losses are significantly reduced since the energy stored in the device output capacitance at turn off is recovered at turn on. Zero- voltage switching also reduces generated EMI in SAZZ converter. From the result, it can be concluded that the proposed system can provide an efficient energy management technique in PV system implemented in remote areas. The model is simulated with MATLAB/Simulink. The converter with predictive control and incremental conductance technique smoothly control the Induction motor.

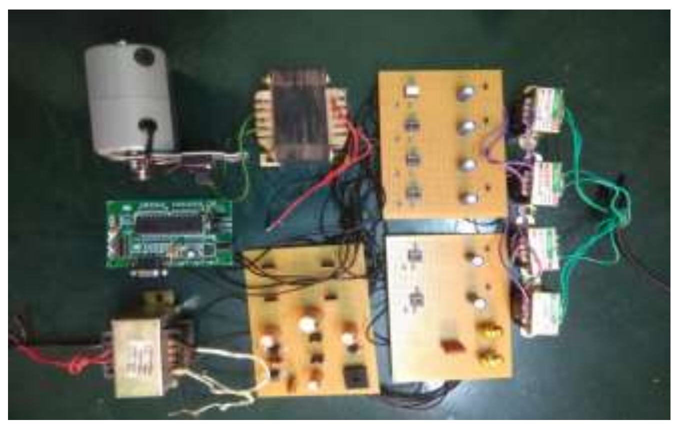

Figure.5 proposed system hardware implementation

In home appliances, washers, dryers and compressors are good examples. In automotive, fuel pump control, electronic steering control, engine control and electric vehicle control are good examples of these. In aerospace, there are a number of applications, like centrifuges, pumps, robotic arm controls, gyroscope controls and so on. These applications may use speed feedback devices and may run in semi-closed loop or in total closed loop. These applications use advanced control algorithms, thus complicating the controller. Also, this increases the price of the complete system.

V. CONCLUSION

In this research, a stand-alone photovoltaic system is offered to supply electricity for the BLDC motor in rural areas with a clean and sustainable source of energy. The ultimate aim of this research was how to increase the system efficiency by employing an effective MPPT controller to transfer the maximum available power to the load especially under rapidly changing atmospheric climate conditions. The Incremental Conductance method offers better performance under rapidly changing atmospheric weather conditions. The output of the MPPT control is given to changing the duty cycle of the SAZZ converter. The SAZZ converter is used to enhance the frequency of conventional boost converters to reduce the converter size and increase the efficiency. The classic INC MPPT algorithm needs the measurement of the PV array voltage *VPV* and current *IPV* in order to determine the correct perturbation direction. The incremental conductance method takes more time for conversion so there will be more power losses in outcome.

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