Electric Propulsion by Combination of Photovoltaic System with Induction Motor Drive

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Abstract

The improvement in propulsion of electric drive is enhanced through PV fed Induction motor (IM) driver. A constant power supply is fed to the load through energy storage element (I.e. battery). The power functioning and manipulation is associated with quazi z source tied for switch three phase inverter. The bidirectional switches can allow charging and discharging. The feedback control loop at outlet of three phase four switch inverter terminal make contribution in changing of PWM signal. The charging /discharging are supported by the quazi network. During charging it degrades the power generated from the source. And during discharging, the converter portion manipulates the voltage regarding to necessity of load. Further the process is carried in MATLAB software to examine efficiency.

Keywords: Quasi Z Source Converter, Three Phase Four Switch Inverter, Feedback Control, Battery, PV, Induction Motor (IM).

I. Introduction

The moment of ship is carried out through propulsion. By the way of conventional method; this continues consistently. Before 21st century most of the ships prefer diesel engine to does propulsion. In primitive method, burning of fossil fuel to generate resource for operating propeller is more popular [1]. Increase in population will cause improvement in transportation. This impact will change some techniques in propulsion of ship. The diesel-electric propulsion arises to eliminate predecessor. But this will degrade environment. In order to concentrate on capital cost, requirement of fuel, environment; electric propulsion is choose [2, 3].

To resolve this electric propulsion method to rotate propeller at instantaneous rate is promoted to deduce uncertainties in conventional method. This impact will change some techniques in propulsion of ship [4-7]. The diesel-electric propulsion arises to eliminate predecessor. But this will degrade environment. In order to concentrate on capital cost, requirement of fuel, environment; electric propulsion is choose. To resolve this electric propulsion method to rotate propeller at instantaneous rate is promoted to deduce uncertainties in conventional method [8].

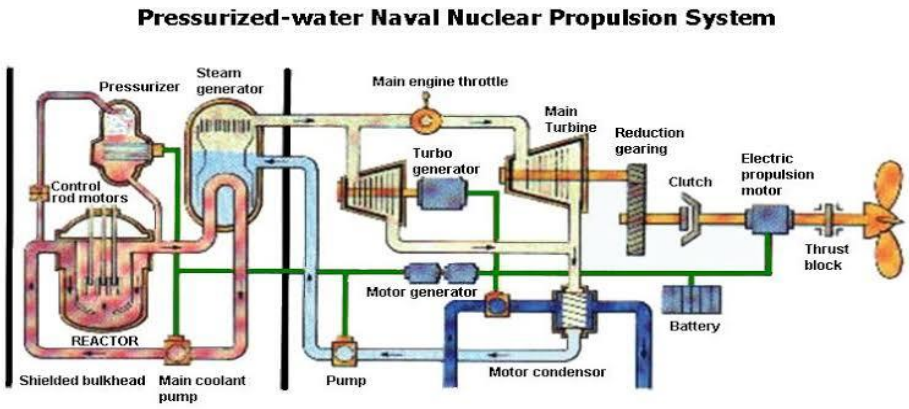


Fig.1. Convectional propulsion system

After the development of electric drives and advancement of power converter, a new iconic in propulsion system is well established. In accordance with environmental impact and increase in rate of fuel consumption, the electric drive propulsion system is accepted in modern era. The key factor for choosing electric propulsion is to attain required torque without intrusion in pitch angle. This kind of propulsion will have complete redundancy [9].

The performance of a drive is adjusted conveniently through control logic alone. Thus control logic has the capability to regulate power flow to the motor; and actuate the propeller consistently. The reasoning of control logic and other current control methodology, the proposed work dealt with accompany of renewable resource tied three phase PMSG drive [10, 11]. The proposed method can have energy storage system to supply continuous power to the load. Solar energy is not available under different climatic condition. In sailing, the nature of climate may vary drastically. At that time the availability of resource is too small and it cannot handle the total need [13]. The roof top PV array setup generates power when will it reach sunlight and it does not face power shading problem. The generated energy is not directly fed to battery; because charging of battery needs a constant supply [14]. As per the above aspects, quasi z source converter is preferred. If any distortions in input voltage, the input filter present in converter topology make it effective and bidirectional switches present in it could perform charging and discharging. The range of battery is said to be a steady state value and it won't allow unusual power. So that converter will optimize power to the battery. During discharging of battery the converter boost the output voltage in respect to the need [15]. A cyclic process of both charging and discharging is performed in a proper manner.

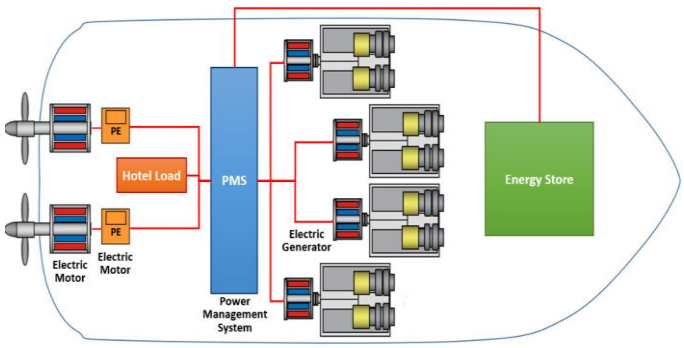


Fig.2. Basic principle behind electric propulsion

II. Summary of Proposed Block Diagram

The Photo voltaic cells generate dc voltage by taking sunlight. A variable voltage with some distortion is carried out from pv panel is fed to the quazi z source converter. Thus four switch three phase converter, eliminate conventional voltage source inverter which requires six switches to convert a dc voltage into three phase ac voltage; but proposed system should possess four switches alone to does the above mentioned one. This inversion technique is controlled by PWM generator. By reviewing the output of driver and its output are feed backed towards control algorithm.

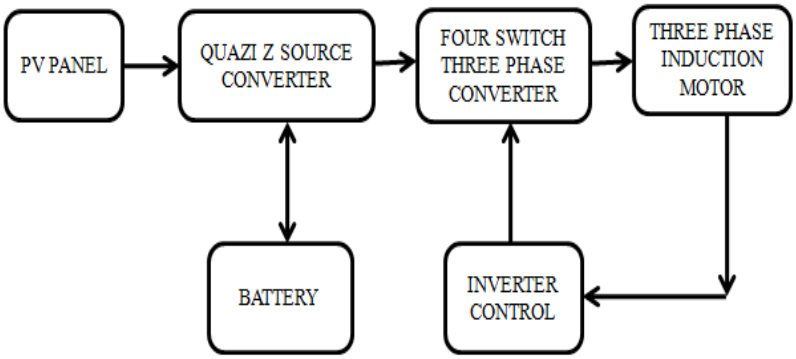


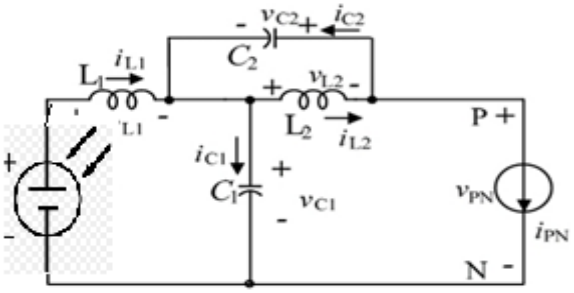
Fig.3.Block diagram of proposed system

The bidirectional switch present in proposed converter can have capability to do perform both charging and discharging enrolled with conversion technique. During charging, the converter step down the input voltage. To satisfy load requirement the low output voltage from battery is stepped up. A battery can store limited charge alone and it is insufficient to accelerate the motor involved in propulsion system. At that condition, the converter makes simpler.

III. Converter Topology

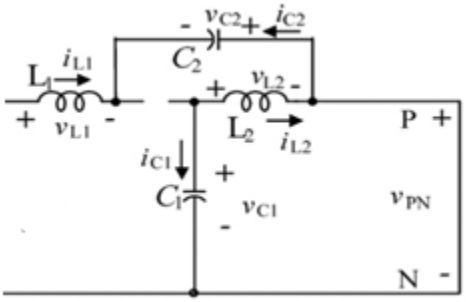
The converter belongs to impedance source topology and its performance is carried in single stage alone. It can do buck/boost operation. Quasi z source network interface source with load and its specialized network configuration boost the voltage in a linear manner. Z source network play a vital role in hybrid power generation, solar, wind, and fuel cells,etc. This is acceptable for differential load conditions. The major reason for choosing this network is: the input inductor can make continuous dc current without any distortion when it is said to be discontinuous. Reduction in switching stress is the additional advantage in proposed method. The overall circuit topology is visualized in below figure. It comprised of pairs of inductor and capacitor, 1 bidirectional switch and a diode.

In this switch is turned on and diode has been forward biased. Then input current energies L2 &C1 via L1. When voltage is cut off the energy stored in L1 tends to move to discharge quickly. Thus energy is stored in other storage element.



(a) mode 1

In this mode D become reverse biased. So that energy stored in other storage devices mentioned in previous cycle keep moving towards load side; this could maintains steady state power flow at load terminal.



(b) mode 2
Fig.4.modes of operation

IV. Result And Discussion

This section dealt with MATLAB software to does the proposed model in the form of simulink blocks. By graphical representation, the propeller action and controllability of power fed to load is examined. A nominal output voltage from solar panel is tremendous.

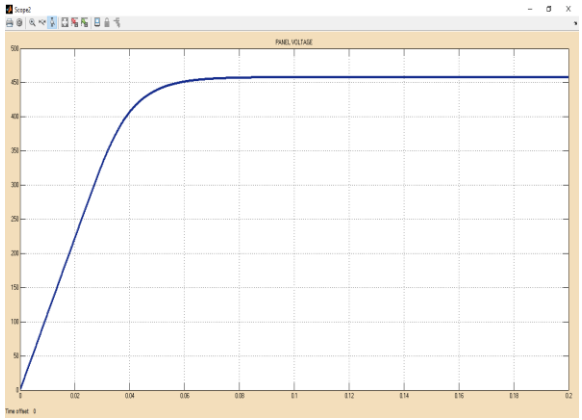


Fig.5.PV array output voltage

The input power source is said to be solar panel. In figure 5 the PV array output voltage is depicted. The solar panel generates nearly 460 volt. The generated power is fed to the converter portion.

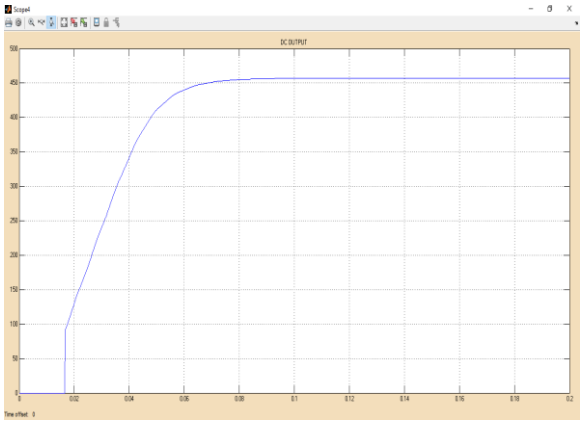


Fig.6.Output of proposed converter

If there is any distortion in input supply, the filter present in it eliminates efficiently. The converter maintains a stable power flow within it to the load.

The following defines efficiency of propeller enrolled with induction motor. The stator current at each phase, speed of operation and torque is explained in it. The motor attached with propulsion is operated at high speed with low starting torque. During switching on motor, the torque is said to be high and it is maintained for a short duration. After that the toque attains steady state value.

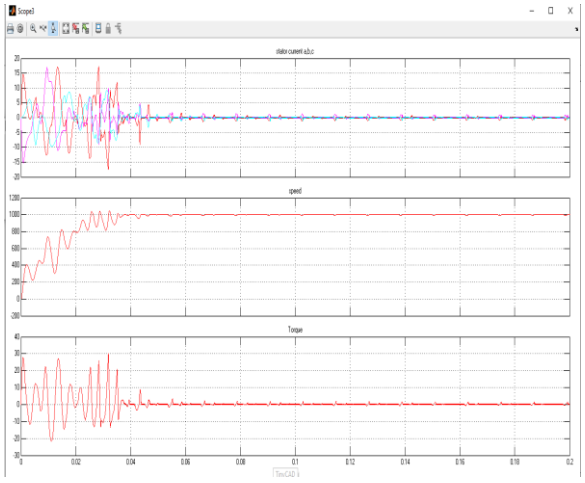


Fig.7.Visualizing stator current, speed and torque of motor

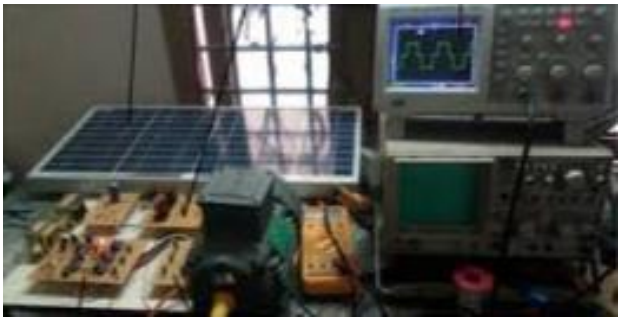


Fig.8. Hardware setup

A renewable energy resource named PV array which supplies a voltage nearer to 12 volt. The microcontroller requires an operating dc voltage of 5volt. The AC grid voltage of 230volt, 50 hertz is driven into step down transformer which converts it into 12 volt with Variation in frequency. The bridge rectifier present in microcontroller section transfer ac into dc but that dc voltage is too high. So that requirement of voltage regulator is essential. The voltage regulator taken 12 volt and delivers rated 5 volt. By this the microcontroller will operate. The generated signal is taken from pin number 21, 22 and it is fed to the driver IC.

Likewise the microcontroller, the driver circuit also receives power from step down transformer. These things will generate essential gate pulse and switches perform well. The distortion in PV array output is deduced by converter section. A controlled DC voltage is finalized and it is converted into three phase ac voltage. Thus motor will act continuously. The below table defines about Hardware components details and specifications.

Components	Specification
PV panel	5 watts, 12V
Step down transformer	230V/12V
Diode	IN4007
Battery	12V
Switch	IRF840
Driver IC	TLP250
Microcontroller	PIC16F877A
Inductor	1mH
Capacitor	100 mF, 35V 100 mF, 25 volt
Resistor	330 ohm, 10 kilo ohm, 100 ohm
Voltage regulator	LM7805

Table I. Hardware components details and specifications

V. Conclusion

The experimental verification of quazi Z source converter employed with four switch three phase inverter based BLDC drive is examined. Apart from hardware, the rotational motion and its acceleration is also elaborated and visualized with the help of MATLAB software. In relation with reduction in switches at three phase inverter also it decreases switching stress, cost and ripple. The preferred algorithm incorporated with speed control of BLDC motor performs satisfactory and devises steady state and dynamic performance more and more efficient and economical. As per the above aspects, propeller can have capability to operate at differential speed with low stating toque.

By choosing different control topology and hybrid renewable resource, the propeller works at affordable rate. It would make economical; a step towards industrial revolution will possible.

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