Solar Powered BLDC Motor Drive for Irrigation Water Pump

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Abstract

The Brushless DC motors are widely used in many industrial and traction applications because of their high efficiency, high torque, low maintenance, less noise and low volume. The BLDC motor can act as an alternative for traditional motors like Brushed DC motor, induction motor, switched reluctance motors etc. The performance of BLDC motor is analyzed using Simulink and then implemented for hardware. The various performance parameters are analyzed using Simulink software. The torque characteristics of BLDC motor is very important factor in designing BLDC motor drive system. Modeling and simulation has been done for “Speed control of BLDC motor using is done using Boost converter”. The Simulation is done in MATLAB / Simulink software for speed control of Brushless DC motor using Boost Converter. Simulation results with regard to stator current, stator back-emf, electromagnetic torque, speed are observed and waveforms are recorded. The hardware has been implemented of using MOSFET as the switching device for the voltage source Inverter.

Keywords: Microcontroller, Solar panel, MPPT controller, BLDC Motor

I. INTRODUCTION

Conventional motors suffer from drawbacks such as low efficiency, high power consumption, inaccurate control, more electromagnetic interference (EMI), and large dimensions. To overcome the drawbacks of Conventional motors, Brush-Less Direct Current (BLDC) motors are being used. The prominent feature which makes Brushless DC Motors different from conventional DC motor is the substitution of mechanical commutation system with the electronic commutation. The mechanical commutation has disadvantages like sparking and wear and tear of brushes and commutator assembly. The hardware has been implemented for water-pump application. Modeling and simulation is done for Solar-powered BLDC Motor-drive. The Simulation is done in MATLAB / Simulink software version 9.1.0.441655 (R2016b). Simulations results with regard to stator current, stator back-emf, electromagnetic torque, speed are observed and waveforms are recorded in the scope. In hardware implementation, uses MOSFET as the switching device.

II. DESCRIPTION

The solar-powered BLDC motor drive for irrigation water pump uses solar panel, MPPT charger controller, battery, boost converter. The circuit uses ATmega 16 Microcontroller, which is programmed to generate six PWM pulses to drive the BLDC motor. The speed can be set to desired value with the help of speed setting potentiometer VR1. The PWM pulses from Microcontroller are feed to opto isolator PC817 followed by the MOSFET driver IC IR2110. The opto isolation is necessary to provide the voltage isolation between control circuit operating at 5V and power circuit operating at 24V. And also driver IC’s IR2110 is necessary to provide sufficient voltage as well as current to drive the MOSFET bridge formed by six MOSFET IRF450.
The 3Phase inverter formed by six MOSFETs generates 3Phase Pulses to drive the 3 Phase BLDC Motor. As BLDC Motor rotates, the hall sensors, which are magnetically coupled to the motor gives the speed sensor pulses. These hall sensor pulses are fed to microcontroller as a feedback to regulate the speed of the BLDC motor to maintain at the stetted speed set by the potentiometer VR1. The Speed regulation has been achieved by varying the width of the PWM pulses given to the Inverter. The speed regulation operation will be done by the microcontroller by comparing with reference voltage from VR1 with DC voltage derived from hall sensor pulses from the BLDC motor.

To power the DC voltage to the 3Phase inverters, a Boost converter has been implemented. This boost converter provides 24V at maximum current more than 2Amp to the Inverter. Because the BLDC motor operates at rated voltage of 24V at 60Watts in the prototype. So, separate control circuit has been implemented for boost converter. This boost converter provides constant 24V to the inverter by sensing the output voltage of the boost converter.

The output voltage for boost converters is derived from the charged battery 12V, which is charged by Solar-panel with the help of MPPT charge controller. Even in the day time also one can run the motor to pump the water if suitable solar panel with high power rating has been used.

Once the battery has been charged, the boost converters can provide sufficient driving voltage to BLDC motor in the absence of sun light, means in night also can run the BLDC motor to pump the water.

A. Advantages

The following are the advantages of BLDC Motor:
1) High efficiency
2) Continuous operation(Heavy duty)
3) Low Power consumption
4) Precise control
5) Speed Stability
6) Constant Torque
7) Wide speed control range
8) Silent operation(low noise)
9) Reliable/long life time (no brushes)
10) High Power/ Size ratio(compact)
11) Low EMI (Electronic Commutation)
12) Compact (no brushes)

B. Applications

The following are the applications of BLDC Motor:
1) Automotive applications: BLDC motors are very useful in Industrial automation. They are less time consuming, high speed operation and reduce manpower.
2) Medical applications: An important application concerns the treatment of sleep apnea which requires the use of Positive Airway Pressure (PAP) respirators BLDC motors are ideal for this application because they are noiseless due to the absence of brushes, which emit audible noise during rotation, thus avoiding disturbing the sleep of the person sleeping next to the patient.
3) Industrial applications: BLDC motors are optimal for switching between high speed and low speed operation, for arbitrary adjustment of speed and also for space saving.
4) Robotic applications Micro BLDC motors in bionic hand prosthesis due to their lightness, small dimensions and energy saving.

III. Conclusion

The proposed work has been implemented for driving BLDC motor using Solar Power. The unit uses boost converters to boost the voltage to a rated voltage of the BLDC motor. The test motor has operating voltage 24V at 60W. The proposed system uses microcontroller ATmega 16 to provide the PWM pulses to control and to regulate the speed of the BLDC motor. The designed unit has been tested with the BLDC motor 24V, 60W, 3000rpm. The modeling and simulation of speed control of BLDC motor using is done using Boost converter is carried out. The Simulation is done in MATLAB / Simulink software version 9.1.0.441655(R2016b) for speed control of Brushless DC motor using Boost Converter. Simulations results with regard to stator current, stator back emf, electromagnetic torque, speed are observed and waveform are recorded.

In hardware implementation MOSFET is used as the switching device for the voltage source Inverter. Hall-sensor based closed loop control technique for the speed control of BLDC motor is used. The BLDC motor speed is controlled by the ATMEGA16 controller based on the feedback from the Hall-effect sensors. The speed of the BLDC motor is measured using Digital tachometer.
REFERENCES

