Design of Low Cost E-Bicycle using Brushless DC Motor with Speed Regulator

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Abstract: This system proposes a simple, cost effective and efficient brushless DC (BLDC) motor drive for battery (BT) array fed E cycle system. A DC-DC converter is utilized to extract the maximum available power from the BT array. The proposed control algorithm eliminates phase current sensors and adapts a fundamental frequency switching of the Z source inverter (ZSI), thus avoiding the power losses due to high frequency switching. No additional control or circuitry is used for speed control of the BLDC motor. The speed is controlled through a variable DC link voltage of ZSI. An appropriate control of DC-DC converter through the perturb and observer conductance maximum power point tracking (INC-MPPT) algorithm offers soft starting of the BLDC motor. The proposed E cycle system is designed and modeled such that the performance is not affected under dynamic conditions. The suitability of proposed system at practical operating conditions is demonstrated through simulation results using MATLAB/ Simulink followed by an experimental validation.

Key Words: BLDC (Brushless DC Motor), ZC(Zeta converter)

I. INTRODUCTION

The story of summer travel in rural areas, and pollution. The best tech app asa Future Electric Bicycles rack option. The E-bike is a battery-operated vehicle thatemits less pollution and requires less maintenance. Electric Bicycles are the most environmentally friendly alternative to both regular bicycles and autos. Being a sustainable and practical mode of transportation. Physically handicapped passengers can travel independently on Electric Bicycles thanks to an uniquemodification. The goal of building an electric bicycle is to demonstrate the benefits of using clean energy rather than a combustion engine to generate power. These cycles are powered by a battery coupled to an electric motor. The performance of the motor can be altered to meet the limits, depending on its type. Electric bicycles are the bridge between commuting faster and commuting safer, electric bicycle reduces the human energy input that makes commuting easier and faster. A normal traditional bicycle moving at its average speed will be around 15-19km/hr., electric bicycles can commute at a speed of 25km/h and maximum speed can be increased even further without the human energy input. An avg person gets tired after 35-45 mins of cycling, in other words, we lose internal energy as we commute by pedaling on a normal bicycle.

This energy that ahuman loses for commuting can be eliminated by the use of an electric bicycle and that energy can be used in other work that requires. The classic boost converter is not a good choice for the high step-up conversion due to following three reasons. Firstly, an extremely high duty-cycle must be used to obtain the steep conversion ratio, which causes serious losses on the power devices due to their parasitic parameters. Secondly, low on-resistance active switches and good performance diodes cannot be adopted due to the high voltage stress. Third, the reverse-recoveryproblem of the output diode is severe due to its short conduction time. All these three factors degrade the efficiency and limit the power level. So, after invention of power semiconductor devices these problems can be overcome. Consequently, a large number of inverters are invented but key components in all these power electronic devices. Particularly in hybrid, electric, and fuel cell vehicles, the Insulated Gate Bipolar Transistors (IGBTs), freewheeling diodes and advanced power module technology are used. After that a Novel PWM scheme was invented for controllingthe output of an inverter with improved fundamental component value.

II.EXISTING SYSTEM

This Project presents a Power Factor Correction (PFC)-based bridgeless Luo(BL-Luo) converter-fed brushless dc (BLDC) motor drive. A single voltage sensor is used for the speed control of the BLDC motor and PFC at ac mains. The voltage follower control is used for a BL-Luo converter operating in discontinuous inductor current mode. The speed of the BLDC motor is controlled by an approach of variable dc- link voltage, which allows a low-frequency

switching of the voltage source inverter for the electronic commutation of the BLDC motor, thus offering reduced switching losses. The proposed BLDC motor drive is designed to operate over a wide range of speed control with an improved power quality at ac mains. The power quality indices thus obtained are under the recommended limits of IEC 61000-3-2. The performance of the proposed drive is validated with test results obtained on a developed prototype of the drive.

III.PROPOSED SYSTEM

The proposed PFC-based bridgeless DC-DC (BL-DC-DC) converter-fed BLDC motor drive. A single-phase Supply followed by a filter and a BL-DC-DC converter is used to feed a VSI driving a BLDC motor. The BL-DC-DC converteris designed to operate in DICM to act as an inherent power factor Pre regulator. The speed of the BLDC motor is controlled by adjusting the dc-link voltage of VSI using a single voltage sensor. This allows VSI to operate at fundamental frequency switching (i.e., electronic commutation of the BLDC motor) and hence has low switching losses in it, which are considerably high in a PWM-based VSI feeding a BLDC motor. The proposed scheme is designed, and its performance is simulated forachieving an improved power quality at ac mains for a wide range of speed Controland supply voltage variations. Finally, the simulated Performance of the proposed drive is validated with test results on a developed prototype of the drive.

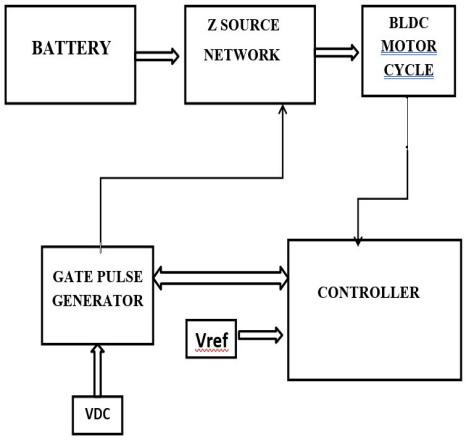

Fig.1.Block Diagram

IV. SIMULATION

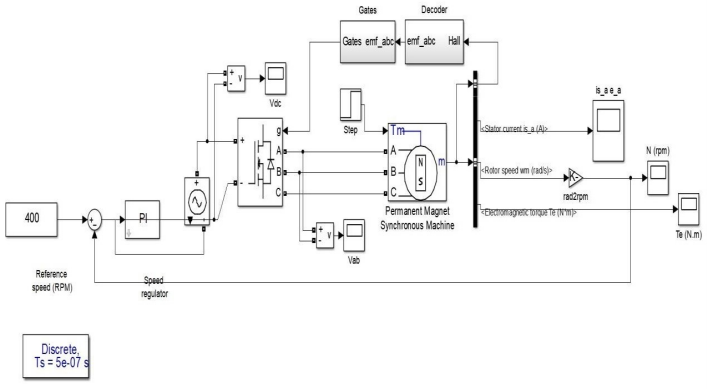

Fig.2.Simulation Diagram

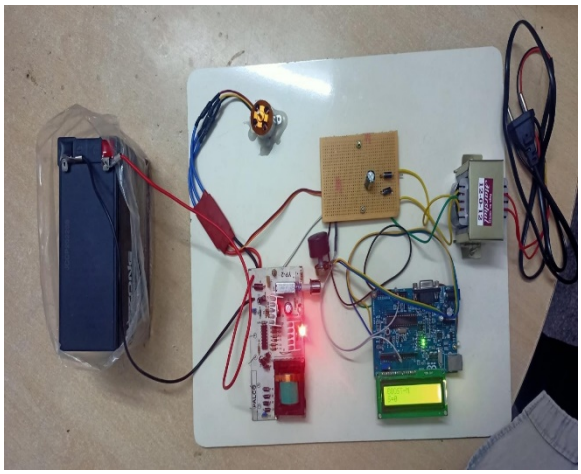

Fig.3. Hardware Implementation

The speed controller typically consists of three main components: a microcontroller, a power electronic circuit, and a feedback sensor. The microcontroller receives signals from the feedback sensor, which could be a Hall-effect sensor or an encoder, and calculates the required power to be delivered to the motor based on the rider's input and the current speed of the motor. The power electronic circuit then adjuststhe voltage and current supplied to the motor to achieve the desired speed. In addition to the speed controller, an e-bicycle with a BLDC motor may also include a battery, a charger, and a display unit to show important information such as speed, battery level, and distance traveled. Overall, an e-bicycle with a BLDC motor and speed regulator provides a comfortable, efficient, and eco-friendly way of transportation, especially in urban areas with heavy traffic and limited parking spaces.

V.RESULTS & DISCUSSION

Electric bicycles, also known as e-bicycles, have become increasingly popular due to their eco-friendliness and low maintenance costs. The use of brushless DC motors (BLDC) with a speed regulator can greatly enhance the performance. The use of a brushless DC motor with a speed regulator in an e-bicycle has resulted in a number of positive outcomes. Firstly, the e-bicycle is able to achieve higher speeds and greater efficiency compared to traditional bicycles. These are becoming increasingly popular as a more environmentally friendly and efficient mode of transportation. E-bikes typically use brushless DC motors with speed regulators to provide smooth and reliable power delivery. These becoming more popular as they are considered an environmentally friendly alternative to gasoline-powered vehicles. They are more efficient, cost-effective and emit no harmful pollutants. The use of brushless DC (BLDC) motor in e-bicycles has gained popularity due to its high efficiency and reliability. In this study, a speed regulator is implemented to control the speed of the BLDC motor, and the performance of the e-bicycle is evaluated. The use of brushless DC motors (BLDC) with speed regulators in e-bicycles has become increasingly popular due to their high efficiency, low maintenance, and longer lifespan compared to traditional brushed DC motors

VI.CONCLUSION

A PFC based BL-DC-DC converter-fed BLDC motor drive has been proposed for a wide range of speeds and supply voltages. A single voltage sensor- based speed control of the BLDC motor using a concept of variable dc-link voltage has been used. The PFC BL-DC-DC converter has been designed to operate in DICM and to act as an inherent power factor pre regulator. An electronic commutation of the BLDC motor has been used which utilizes a low-frequency operation of VSI for reduced switching losses. The proposed BLDC motor drive has been designed and its performance is simulated in MATLAB/Simulink environment for achieving an improved power quality over a wide range of speed control. Finally, the performance of the proposed drive has been verified experimentally on a developed hardware prototype. A satisfactory performance of the proposed drive has been achieved and is a recommended solution for low- power applications.

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