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Design of Electronically Commutated Motors for Motors for Hybrid Vechile for Braking

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Abstract

The best answers to the fuel crises compelled to survive made a sustainable road transportation. One such effort in this regard is reported in this paper. Due to overcome of power electronics, the population of hybrid vehicle is also hiking up day by day. The Brushless DC motor is considered as potential drive to automotive applications such as the (Hybrid vehicles). Design of a direct drive, Brush less DC motor is employed (BLDC) or (electronically commutated motors). Many constraints have been considered, such as the size of the motor, maximum driving current and maximum output power. The diameter and the stack length are limited by using modern analytical tools of the prototype vehicle. Nobel analytical tools are used to obtain static and dynamic characteristics of the motor and geometrical verifications for low cost efficient design. A low cost electronic controller compatible for present application has been developed and designed in this paper. The prototype is fabricated and tested on a light weight electric vehicle such as the car and two wheeler. This automotive model's performance was tested and its results are simulated in this paper. It has lot of advantages such as the generating power by regenerative braking at speed barkers, recharging the battery while the vehicle is in under the motion.

Keywords: Brushless DC motor, regenerative braking, recharging, motor, BLDC Motors.

1. Introduction

Nowadays, the hybrid electric vehicles play a vital role and it creates a resolution in automobile sector. In internal combustion engine utilizes fuel as the source and it produces lesser efficiency due to heat in the IC engine. In existing system, the electric motors are used in the hybrid electric vehicles (*two wheeler*) those electric motors has commutator and brush gears in it, with the help of these components the sparking produced in commutator segments and brush wear problems are created in electric motor [7]. This problem causes the brush and commutator damage and frequent maintenance is required. The speed reduction gear in hybrid electric vehicle decreases the efficiency of the drive and increases the weight of the drive train. To overcome these problems a brushless DC motor drive is employed in our proposed project

This drive are advantageous, it has less maintenance, long life, low EMI and noiseless operation they consume low input power and provide high output power when compared to permanent magnet or shunt wound motors and gear motors. The BLDC provide very high starting torque, maximum driving current and maximum output power for electric traction when compared to other motor drives. Many topologies had been consider such as the size of the motor, maximum driving current and maximum Output power .In this paper, the regenerative braking is employed to improve the efficiency of the drive and braking also done. The lower rotor inertia of BLDC motor drive improves the acceleration and deceleration times while shortening operating cycles and their linear speed-torque characteristics produce predictable speed regulation. In this paper, the design and construction of a BLDC motor drive for use on a hybrid electric vehicle will be described and their design features and specific applications are highlighted. Prototype has been made and its experimented results are obtained to demonstrate the features of the proposed BLDC motor design.

2. Working of a four wheeler

The BLDC motor for use on a hybrid electric vehicle (*four wheeler like cars*), [1] should be small in size, light in weight and should have a high efficiency. On considering the space limitations, the motor must have a short axial length. The BLDC motor must provide sufficient torque to overcome the load at roads like aerodynamic, the rolling resistance, drag, the tractive force against the gravitational pull when climbing up a slope, and the tractive force for acceleration. Rolling friction depends on both type and road surface characteristics that mean interaction between these two; here use the type material depends on the road type the diameter and the stack or limited by the tire size of the hybrid electric vehicle most widely used hybrid electric vehicle are designed as fuel consumption cars. They usually perform at a speed of 40-50mph. but the present day traction batteries provides much significant improvement as per performance and range. Nowadays in hybrid electric vehicles, nickel cadmium or Lithium ion batteries are used [2].

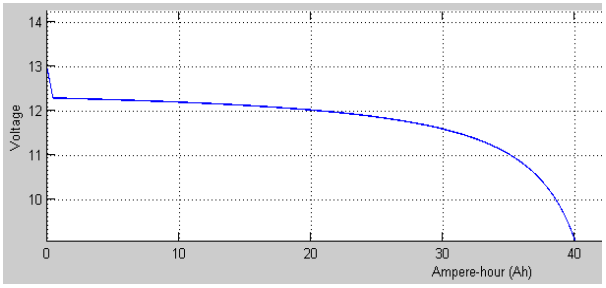

Figure.2.Discharge curve of the 12V/42Ah battery

These types of batteries are more flexible lighter when compared to the regular batteries in automotive applications

3. Operation

In existing system linear induction motor (*with brush*) is used in two wheelers. We are upgrading and implementing the concept for four wheelers by providing the BLDC [3], [4] motor to avoid brush wear problem and sparking effects. In this proposed system four BLDC motors are used in the each wheel. The two motors are connected at cross angles for the mutual balancing and for better control of vehicle, when the steering rotates at the edges and curves. The load to the motor is equally split up in the rating corresponding to the motion of the vehicle. The toggle switch is used to control the speed of the motor automatically when the accelerator releases. In addition external braking is used for the safety purpose and sudden stopping of the motor. Two batteries are used for the forward and reverse operation. In case of battery drained the supply can be altered from the other battery. In addition solar panel is used to improve the usage of charge and charging the batteries under the vehicle's running condition. When the vehicle reaches more than 40 Km/h rotor position sensors will reduce the speed of the motor [5], [6]. Hence the vehicle will runs under the rated speed are displayed on LCD display unit, as shown in fig.1. Regenerative braking is used to improve the motor efficiency and also used to decrease the speed when climbs the slope

4. Vehicle parameter

Sl. no	Parameter	Value	Units

Sl.no	Item	Description
1	Volts	78 V, DC (Voltage range from 43V to 55V)
2	RPM	520 RPM (40km/h at max load)
3	Output power	6 kw
4	Current (amp-max)	100 amps
5	Efficiency	>80%
6	Insulation class	B
7	Winding temp.rise	45deg C
8	Max body temp	55deg C
9	Bearings	Sealed Bearings
10	Body type & material	Aluminum/cast iron body
11	Rated torque	19.8NM
12	Ambient ° C	-15 deg C to 55 deg C
13	Cooling	Natural

Table.3. Proposed System Design Specification

6. Peripheral features

a) Timer0: 8-bit timer/counter with 8-bit presale

1	Total mass of vehicle, people, and cargo(m)	200	Kg
2	Maximum acceleration from IDC	2.6	m/s^2
3	Coefficient of normal tyre rolling resistance (Crr)	0.052	
4	Density of air, approximately air approximately (Pa)	3.92	Kg/m^3
5	Drag coefficient (Cd)	0.8	
6	Frontal area (Af)	0.12	M^2

Table 1 Proposed System Vehicle Parameters

5. Design and experimental performance comparison

Sl.No	Parameter	Designed Value	Exp Value
1	Full Load Output (Watts)	500	504
2	Torque (N-m)	90	85
3	Full Load Speed (RPM)	520	562
4	Full Load Current (Amps)	12.5	12
5	Full Load Efficiency (%)	86.89	87.88

Table.2. Design and experimental performance comparison

b) Timer1: 16-bit timer/counter with prescaler, can be incremented during sleep
c) Via external crystal/clock
d) Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
e) Two Capture, Compare, PWM modules
f) Capture is 16-bit, max resolution is 12.5 ns,
g) Compare is 16-bit, max resolution is 200 ns,
h) PWM max. Resolution is 10-bit
i) 10-bit multi-channel Analog-to-Digital converter
j) Synchronous Serial Port (*SSP*) with SPI. (*Master Mode*) and I2C (*Master/Slave*)
k) Universal Synchronous Asynchronous Receiver Transmitter (*USART/SCI*) with 9- Bit addresses detection.
l) Brown-out detection circuitry for Brown-out Reset (*BOR*)

7. Results

In our project the design of In-wheel, permanent magnet BLDC motor drive for powering an electric car is developed and constructed. Two dimensional finite element methods are used for computing the magnetic field distribution, from which the motor performance can be determined a prototype motor has been built together with the electronic converter circuit. Preliminary tests on the prototype motor drive demonstrate the feasibility of the proposed design for electric car applications

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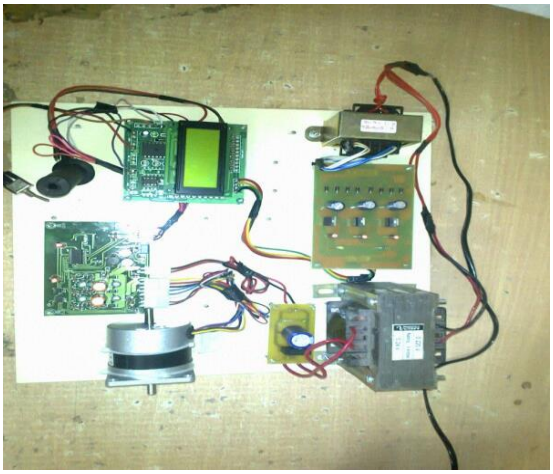

Figure.2. Circuit of BLDC Motor application (OFF state)

Figure3. Circuit of BLDC Motor application (ON State)

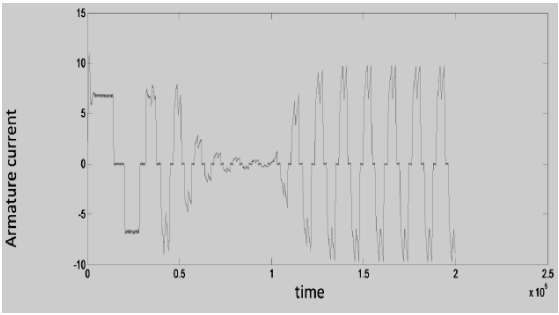

Figure.4.Armature current of electric drive circuit

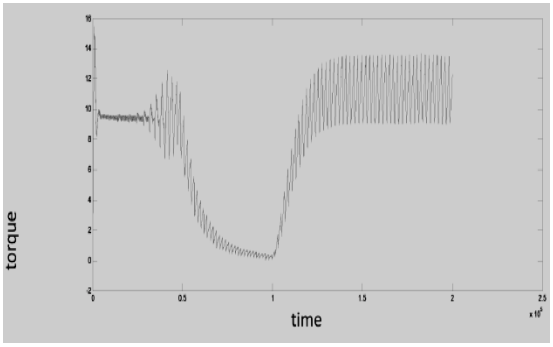

Figure.5. Output torque of BLDC motor at no load

The above fig.2 & 3 is the prototype model of our proposed system it consists of four units stating from input supply to the motor controlling circuit. The output waves are obtained by stimulation output in corresponding with the experimental results, fi4.4. Shows the input and output waveforms of the boost converter. The fig.4, 5, &6 shows the output waveforms of the current, speed and output torque of the BLDC motor.

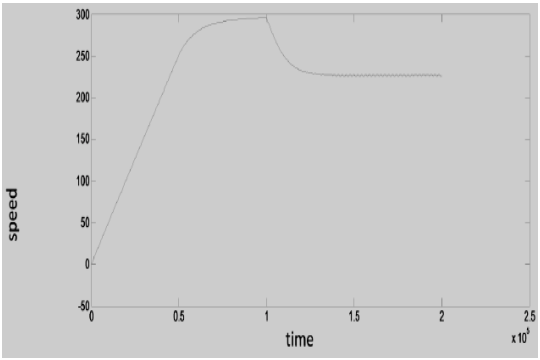

Figure.7. Speed of BLDC motor at no load

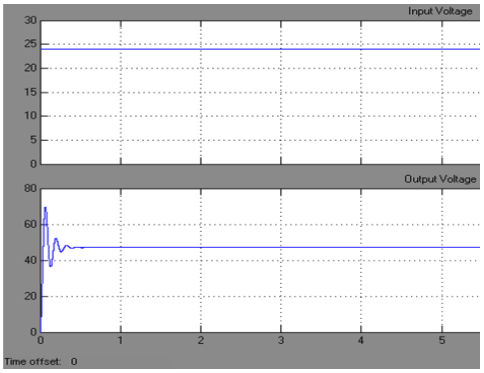

Figure.6. Input and Output voltage of the boost converter

8. Conclusion and future work

In this paper, the design of a permanent-magnet Brushless DC motor drive for powering hybrid electric vehicles described. Two dimensional finite element methods are used for computing the magnetic field distribution, from which the brushless dc motor performance can be determined. A prototype hybrid vehicle has been built, together with the advent of power electronic converter circuits. Preliminary tests on the prototype motor drive demonstrate the feasibility of the proposed design for hybrid electric vehicles and also it has more efficient method for generating the power by using regenerating braking for recharging the battery in efficient manner. And also in future we can run the vehicle by dual energy, battery power as well as fuel and also we can capture wind energy which is naturally available from vehicle motion and its utilize for battery charging

while in long travelling. So we can reduce uses of fuel as well as electricity and also less losses and more efficiency.

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