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Designing and Fabrication of E-Bike : Economical Electric Transportation

Munna Prasad[1], Abhishek Singh[2], Rishav[3]
[1-3] Electrical Engineering Department, Chandigarh University, Gharuan, Mohali, Punjab, India

ABSTRACT

The electric vehicles industry is continuously evolving. One type of such electric vehicle is the electric bicycle (e-bike). Electric bicycles, like other electric vehicles, use a BLDC motor (Brushless Direct Current Motor). This paper presents a way of designing and implementing an electronic module for an e-Bike. The paper shows how a low power, 8-bit microcontroller can be used to drive such a motor and also manage other useful functions on an e-Bike.

Keywords : BLDC, e-Bike, Controller, Motor

I. INTRODUCTION

Electric vehicles make use of BLDC motors as the propulsion method. Due to the fact that BLDC motors do not have brushes they present some advantages over the DC brushed motors, from which we remember: (1) longer life span, (2) lower EMI (Electromagnetic interference) radiation, (3) noiseless operation, (4) grater torque to motor size ratio (5). Due to the geometry of the windings in the motor, the BEMF (back electro-motive force) generated by the motor when in generator mode. that can be of two typesthe latter can be of interest if the driven motor does not have Hall position sensors, and facilitates the calculation of the motor's rotor absolute angle. The structure of a BLDC motor is presented in Fig. 1. BLDC motors are 3-phase motors, and to properly drive such a motor, a special control circuit (controller) Fig-2 must be used. The purpose of the control circuit is to energize the correct winding(s) at the right moment. This is achieved by reading information from certain rotor position sensors and generating PWM (pulse width modulation) signals.According to [2].The modern e-bike are best in case of energy conservation and efficieny. The main components of a system with BLDC motor are: (1) control logic, (2) power stage comprised of six switching devices (e.g. MOSFETs, IGBTs) and (3) sensors used for the closed-loop feedback. The performance of a BLDC motor is dictated mainly by the motor structure and the control logic that is been used. By using different types of control logic, the torque ripple of the BLDC motor can be minimized.

II. BLOCK DIAGRAM

The block diagram of the designed electric system is presented below. The implementation of the proposed control unit is based on an 8-bit microcontroller. The microcontroller receives information about the motor position (rotor angle), via signals generated by three Halleffect sensors contained within the motor. Using this data, the microcontroller uses a simple commutation table and switches the six power MOSFET transistors which

drive the BLDC motor. Internet-based literature (images only) suggests that BLDC controllers used in commercial e-Bikes contain linear power supplies. This is a main issue regarding power efficiency, due to the significant power loss as heat in the internal power supply.One of the improvements this design brings is the use of a DC-DC step down converter, which greatly lowers the power consumption of the module and reduces the ambient temperature in the case of the module. The latter is an important issue, considering the fact that the electronics on an e-Bike must be housed in a water-proof enclosure. The user of the e-Bike receives relevant data (e.g. instantaneous speed, battery state of charge) from the motor controller via Bluetooth protocol and can view the data on a GUI (graphical user interface), i.e. on a smartphone. By using a Bluetooth transmitter instead of a graphical display, the power consumption is furthermore reduced.

III. ELECTRONIC SCHEMATIC

The hardware implementation of the block diagram is presented in Fig. 1, without the power stage. The power supply is designed using a dedicated DC-DC step down IC (integrated circuit) – U101 in Fig. 3 a. By using an IC with integrated power MOSFETs, EM radiations are reduced, due to the fact that there are no necessary external traces on the PCB. The circuit requires the existence of a negative supply rail. This is achieved by using a 555 timer, U104, in a switched capacitors configuration. Other supply voltages are obtained using LDO (Low dropout) regulators. The combination of a DC-DC pre-regulator followed by linear regulators provide a low output voltage ripple, while maintaining a good overall efficiency. In Fig. 3 b the logic circuitry of the controller is preseThe heart of this block is an AVR ATmega128 microcontroller, U201. This solution has been chosen as a good compromise between processing power and low consumption. In order to increase the EM radiation immunity of the microcontroller, the voltage supply level of the microcontroller is the maximum allowed, i.e. 5V. The interface between the microcontroller and the Bluetooth module is made using a bidirectional level shifter, comprised of Q201 and Q202 transistors. The level shifters are necessary because the microcontroller and the BT module are powered from different supply voltages (5V and 3.3V respectively).

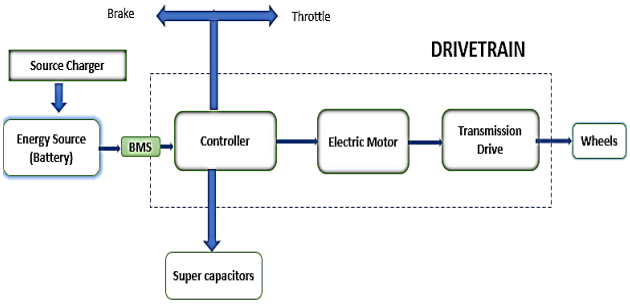

Fig-1 Architecture of an E-Bike

IV. SYSTEM CONFIGURATION AND SPECIFICATIONS

The speed controller of an electric bike is an electronic circuit that not only controls the speed of an electric motor but also serves as a dynamic brake. This controller unit uses power from the battery pack and drives it to the hub motor. Different types of controllers are used for brushed and brushless motors. As [4,5&6]. The controller and charger should cost effective and light in weight to which increase efficiency of bike. As shown in table 1 below.

Table 1- Specifications of controller

Specification	Rating
Voltage	48V
Wattage	800W
Throttle	1-4V
Rated current	33A
Under voltage protection	48V

V. SPECIFICATIONS OF MOTOR

As the speed controlling of BLDC motor is difficult. Several electric bike drive solutions are currently available on the market. The most common solution is setting the electric motor speed using a shifter located on the bicycle handlebar. In the case of using the electromagnetic torque control for the motor driving the bike, it is possible to use a new principle of operation of the drive. Such control consists in setting the load torque on the connecting chain with gears as a difference between the determined load torque on the driven wheel of the bicycle and the electric motor torque. The presented method makes it possible to determine the work of the biker. The design specifications of the motor are summarized in They are considered as meeting there requirements of the battery and the controller as well as the own performances of E-bike. The rated output power of the in-wheel motor was experimentally settled as 500W by considering the weight of the E-bike and the capacity of battery. The rated torque of 102-Kg-cm was calculated as the proportion of peak-to-peak rated torque values in the rated torque. In order to achieve cost-effective fabrication, the following two needs to be examined during the design process, One is the solid core used in the rotor part, The other is the optimal design of stator part used for automatic winding. The material of the rotor core was decided by analyzing the characteristics of the prototype)A good Lithium battery pack can cost as much, and often even more than the rest of your electric bike kit. Picking the right pack for the job is very important.

Table 2. specification of motor

Specification	Rating
Rated operating voltage	48V
Rated power	500W
No load current	4.0A
No load speed	516 RPM
Rated torque	102Kg-cm
Rated speed	450 RPM
Rated current	13.4A
efficiency	80%
Gear ratio	1:6
Type	Brushless DC
Dimension	L=233.4, D=140.5

Table-3 specification of battery

Rated voltage	48V
Ampere hour	20ah
capacity	960W
Type	Li-ion

VI. CONCLUSION

As the now days we all are suffering from global warming due to burning of fossil fuel so we have to choose another option so we should prefer electric vehicle and the electric bike ,electric bike is most economical way of transportation and there are several advantage of electric vehicle like it is affordable to all family ,most cheaper as 0.5 rupees per km ,environmentally friendly ,and less maintenance cost.

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