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Power Saving Techniques in Electric Bike

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ABSTRACT: Different brands of Electric bikes are available in the market at present. In all most all Electric bikes a rear wheel BLDC (Brushless DC) hub motor, lead acid battery pack, a light weight chassis, and a controller is placed. The Vehicle speed range from 40- 60km/charge. The charging time is 6-8 hrs which is very long and lifespan of batteries is short i.e. around 2 years. Considering these limitations in this paper we are giving solutions to modify the existing design to give a better performance. Super capacitor modules help to increase the lifespan of battery. Regenerative braking or a small solar panel module could be availed onboard so as to charge battery or super capacitor. Along with the inclusion of solar panel modules and super capacitors, pedal system in electric bike also saves lot of battery power.

KEYWORDS: E-bike, BLDC, PV module, Li-ion battery, LEV.

I. INTRODUCTION

The electric bikes which are available and are affordable incorporates a rear wheel BLDC (Brushless Direct Current) motor which is suitable and compact. The battery pack is a series combination of cells, a controller which controls the power transaction. Batteries are generally lead acid which are cheaper compared with other types. A potentiometer box is present which acts as accelerator along with other minor circuitry and accessories. With these specifications, E-bikes give 40km-60km/charge range. Using solar energy to build solar charging modules for charging electric bikes and electric motorcycles is a practical application of sustainability. Solar charging modules convert solar energy to DC electricity and this DC energy can be stored in a battery pack.

The control of the E-bike is done by using chopper control and in turn by using an microcontroller to regulate the analog input from the throttle. The motor drive used for the model would be a DC series motor. Hence the model of the electric bike would be simple in design as well as efficient. The rim of the cycle would have to be specially designed. The general E-bike model would use an extra groove in order for the motor axle to be attached. Sufficient gears may have to be used for the motor speed to be in sync with the desired speed to be reached by the E-bike. The starting current of the motor reach up to 30A during starting, in order to drive such a system we designed a MOSFET assembly connected parallel [1] to each other to drain such a large current out. A heat sink of sufficient dimensions and heat sinking capabilities are used for MOSFET mounting. IRFZ44 MOSFET has a current bearing capacity much more than the running current of the motor thus suiting the application. The gate of the MOSFET is shorted to each other and is triggered by the pulse generated from the microcontroller. The drain is connected to one of the motor terminals while the other terminal is grounded, along with the source of the MOSFET.

Electric bikes are light electric vehicles (LEVs) used for convenient local transportation in all over the world. Designed for one-person capacity, these pedal-driven e-bikes include two wheels – one at the front and other at the rear – attached by a frame. These e-bikes are available in two variants, namely, bicycle style and scooter style. The bicycle style ebikes are supplemented by electrical power from a storage battery. On the other hand, the low-speed scooter style e-bikes are propelled by electricity [6]. There are numerous benefits to owning an electric bike such as get fit, save money and time, go faster, further, fresher, green and have fun [2]. But, up to now, there are some constraints for e-bike to be the first local transportation, especially in Egypt; such as: high cost, limited speed, storage element charging, etc. Especially lead acid batteries degrade heavily over time (500–800 charge-discharge cycles), so a bike with lithium batteries is an advanced technique. The decomposition of batteries is not eco-friendly. The weight of batteries also adds to more than half the weight of the bike.

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II. OVERVIEW OF THE MODEL

The electric consists of 250w,500w,750w 48V/60V geared BLDC rear wheel hub motor, driven by a 48V/60V 20Ah battery pack. The supercapacitor bank consisting of a 16V, 58F to be connected in parallel with the battery pack via a buck boost converter which is designed to harvest the maximum energy from it. Microcontroller circuitry senses various parameters and performs switching and controlling action. The controller is the heart of E-Bike which regulates controlling actions and power through each subsystem. Throttle is a potentiometer box which acts as an accelerator. The Solar Charging module harvests the solar energy and helps to charge electric bikes/electric motorcycles. The Solar Charging Stations utilize solar PV modules to convert solar energy to DC voltage.

Fig. 1 Pedal system in Electric bikes

Fig.1 shows pedal powered electric bike, which would save lot of power for the consumer. Depending on the speeds required, gearing mechanisms can be added to the shaft of the motor. The gearing mechanisms avoid cases of undesirable speed limits. Another model which can be used involves a direct coupling to the chain driving the wheel, thereby avoiding the extra cost of altering the rim of the electric bike.

Ebike sharing systems are expected to contribute, among others, for:

- Reduction of single occupancy journeys with cars, and thus ease of traffic congestion,
- Reduction of CO2 emissions from motorized traffic, and thus improvement of air quality,
- Increase of physical activity levels and improvement of public health,
- Improvement of accessibility and flexibility of mobility.

The DC energy can be stored to a battery bank by charge controller India is a country where cycles are popular among youth and the elderly alike. It would be of great value if more pedal powered electric bikes are available in the market at low cost [8]. So we provide a solution to the existing problem by modifying an existing model of the system. The existing pedal powered bicycle is becoming of lesser importance to the general public because of the coming into existence of faster modes of travel like the bikes, which are in fashion. So it would be ideal if we use an old model of the bicycle and convert it into a more effective model such as the E-bike by the attachment of a prime mover like the motor and power it by the use of the lithium batteries.

III. TESTING AND OBSERVATIONS

Fig. 2 shows the solar module placement in an electric bike. Solar charging system is built for charging electric bikes. The load of the electric bike is 2500Wh (Watt-hours). Three 265 watts solar PV modules are used to get a total maximum power output of 795 watts. It is known that the output voltage of a PV module is influenced by the ambient temperature [6]. The range of the voltage output due to the extreme temperature should be within the specification of the charge controller. The range of DC output voltage from PV modules Charge controller The charge controller

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receives and regulates the input voltage from PV power source and stores the energy by charging the battery bank [5]. The D.C supply used for the E-bike model is a 48V/60V, 20 Ah battery, lead acid type due to its ease of availability and its low cost. Otherwise one can use two twelve volt batteries of the same ampere hour rating to achieve 48V/60V rating.. The batteries are directly fitted onto the frame of the electric bike and are fixed in place (preferably by locking it onto the frame, or by welding) [3]. The advantage of using lead acid batteries over other source such as Li-ion and Ni-Cd are its ease of availability, as well as their lesser expense and the absence in requirement of a battery control pack. Compared to the economical price at which this battery is available it provides the maximum power density in terms of the quantity of the energy produced per pound and its long lasting life. This kind of acid battery also has huge advantages in terms of environmental protection.

Fig. 2 Solar modules in Electric bikes

Recycling of lead-acid batteries over other sources such as Li-ion and Ni-Cd are its ease of availability, as well as their lesser expense and the absence in requirement of a battery control pack. Compared to the economical price at which this battery is available it provides the maximum power density in terms of the quantity of energy produced per pound and its long lasting life. Recycling of lead-acid battery can be done at an exceptionally high rate. According to the survey reports it is said that about 97% of these batteries are recycled and can be reused in the making of new batteries [7].

Fig. 3 Lithium ion batteries for Electric bikes

Fig. 3 shows the Lithium ion battery which can be used for electric bike. The advantage of this battery compared to Lead acid battery is long battery life and less weight. The motor used is DC series motor rated at 500W/750W and 48/60 volts with the maximum current flowing in as 30A. The motor is selected because of the fact that it provides the high starting torque necessary for overcoming the static friction at the start of the operation [9]. The dc series motor is also selected because of the fact that it requires chopper control which is simple and effective. Hence a D.C series motor adds up as an efficient and effective choice when it comes to the selection of prime mover for the E-bike. The

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motor has a maximum speed of 3500 rpm. The insulation used in the motor is F-class insulation which has a temperature capacity till 120 degree Celsius. The motor is a 4 pole 4 brush with number of commutator segments as 29. The motor is designed so as to enable a gear ratio of 20:1. The estimated rotating speed of the shaft attached to the motor is 0-400 rpm. Considering a stable mechanical system, the whole electric bike assembly can go up to a speed of 70 km/hr [4]. The E-bike model would use a D.C supply which would be sufficient to feed the motor with its required rated voltage, and the supply circuit should be properly set so as to avoid an excess of current to the different parts of the driving and control circuits. D.C supply can also be used to feed the driver circuit as well as the control circuit which both requires different voltage levels. The driver circuit, which is an optocoupler such as Toshiba photo coupler TLP250F, would provide adequate voltage for driving the MOSFET switching circuit. D.C supply can also be used as the supply for the control circuit, which is done using analog circuitry or microcontroller, both which requires appropriate biasing. This is also achieved using resistive divider, or better still, op-amps such as LM741, which helps in creating the same effect.

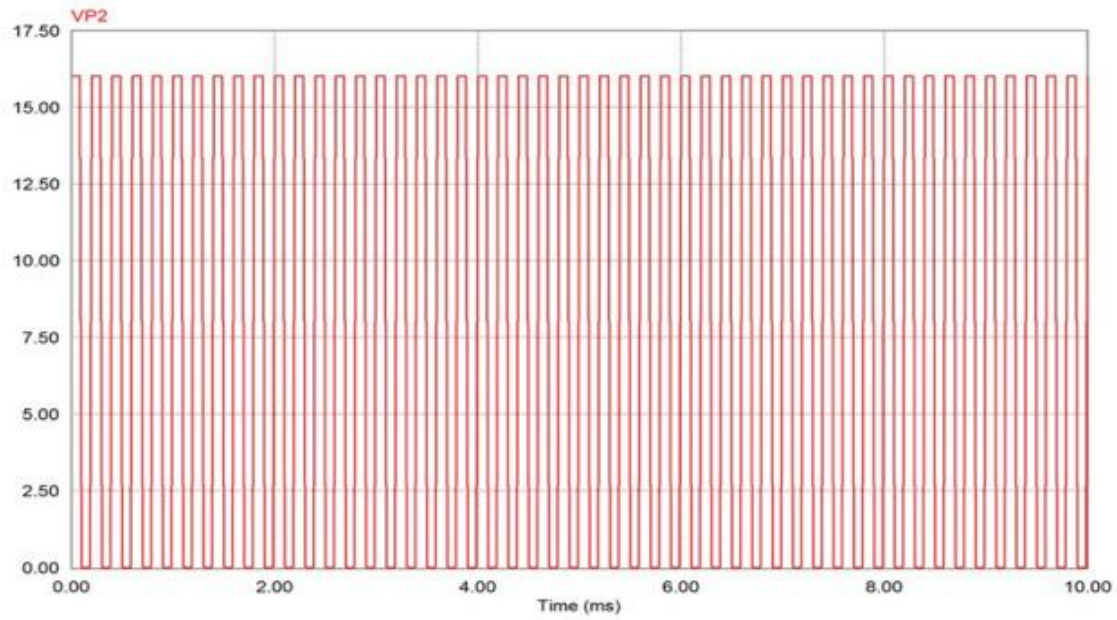

Fig. 4 PWM output of the microcontroller

Fig. 4 shows the PWM output of the microcontroller. Hence by using Solar panels, regenerative braking, super capacitors and pedal system techniques in electric bikes, the drawbacks of electric bikes can be overcome to give mileage around 80 to 130km/charge. Since our design involves regenerative braking with 2 modes. We have achieved maximum range of 90 km / charge. As super capacitor relieves the heavy usage of battery current, we could expect an extension in battery life of above 2 years. If we apply the parallel charging technique in the proposed model in addition with onboard solar panel, the battery charging time has been reduced to a nearly 60 percent.

IV. CONCLUSION

The paper discusses Solar panels, regenerative braking, super capacitors and pedal system techniques for electric bikes to increase the performance in terms of cost and efficiency. The model discussed had features like dual modes of working, i.e electric motoring as well as pedal powering to give mileage around 80 to 130km/charge. Effectively the model of the electric bike could be incorporated with a system for regenerative braking, thereby charging while in motion. Also there is a scope for adding a system for ABS, which would greatly add to the stability of the model, while in locomotion. Also the batteries can be replaced with more efficient Li-ion batteries which would be adding to the effectiveness of the model.

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