iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: V Month of publication: May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5463

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Power E- Bicycle

Ramchandra Nittala[1], G. Sridhar Babu[2], V. Sumadeepthi[3]
[1]Dept. of EEE, [2]St. Martin's Engineering College, [3]Malla Reddy Engineering College

Abstract: The Electric Bicycle System is modern electrical bicycle that incorporates two different ways of charging a battery: the 230VAC wall outlet, regenerative braking, and solar power; which is used to power an electric hub motor running a bicycle. The purpose of this bicycle is to show that it is possible and relatively simple, to build an electric bicycle by oneself. The manufacturing of this bicycle can be divided into four separate categories: the lead acid battery, the motor, and the motor controller and dynamo. Each of these will be built upon and improved further by future students, one category at a time. The anticipation is that this design can become very efficient, cost-effective, and one day mass-produced, especially in developing countries where automotive transportation is an impossibility.
Index Terms: Power E bicycle, Regenerative system, motor, dynamo.

I. INTRODUCTION

The electric bicycle offers a cleaner alternative to travel short-to-moderate distances rather than driving a gasoline-powered car. In recent years the price of crude oil has increased significantly over the past few years and there seems to be no turning back. The environment has also been more of a focus throughout the world in the past few years, and it seems that cleaner alternatives have been steadily on the rise with no end in sight. The electric bicycle is a paper that can promote both cleaner technology as well as a lesser dependence on oil. It will run on clean electric power with the ability to recharge the battery 2 separate ways: through the 230 VAC source, by generating power through the pedals of the bicycle through DYNAMO . An extra benefit to building the electric bicycle is that it can also show the general public how much cheaper it would be to convert their regular bicycle into an electric bicycle rather than driving solely in their gas-powered vehicles. The greater importance of the environment in the world leads to an opportunity for students in our position. With the economy trying to get out of one of the worst depressions of the century, there are numerous opportunities for us to help out. This is our opportunity to contribute a greener and more efficient planet.

II. DESIGN REQUIREMENTS

The basis of this paper is to construct a system for an electric bike. There are many key components within the block diagram. They consist of a lead acid battery, a motor controller, a Dynamo, a Hub motor. The Quick switch and throttle/cruise controller are simple button systems that are used to trigger the functions for increasing speed, keeping the speed constant, and turning off the motor.

The power source for the system was a DC battery source chosen to output 24V, which was the maximum output voltage. Lead acid battery was the most efficient choice for an electric bike because it offers high energy density while remaining relatively light-weight and compact in size. Lead acid batteries can be very dangerous; therefore, it is essential to research the quality of the lead acid and the protective implementations used. The battery has a high voltage rating diode at the output and uses it as a current protector. This is essential to the paper requirement for interfacing multiple forms of charging such as mechanical energy, and high AC voltage through an outlet.

The battery block is interfaced with the motor controller block. The motor controller controls all the functional capabilities and is the central component of the system. The basic requirement for the control is to regulate the amount of power applied to the motor, especially for DC motors. The motor controller can be adjusted to synchronize with other brushless motors. There are also many built-in functions for this controller that vary from detecting any malfunctions with the motor hall sensors, the throttle, and the brake levers to protect functions against excessive current and under-voltage, which are ideal for protecting the battery. These functions are beneficial to the success of this paper and also provide a solution to any troubleshooting and damages that may occur.

The control allows the battery to interface with the motor to be bidirectional which can supply and receive power. Software is provided with the controller so that it can adjust the setting and operations for several of the controller's functions.

Another source of battery charging comes from the dynamo. For an output power of 100 watts or higher need to run the cycle with high speed. Its primary purpose is to provide a longer life cycle for the battery we provide an battery indicator.

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III. DESIGN FEATURES

A. Bicycle

The bicycle which was used for making the electric bicycle is a sports bicycle. It can bear upto 150kgs weight.it can move with 30kmph.

Fig 1: Picture of bicycle

B. DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Choosing a motor was the first step in creating an appropriate system for the electric bike. Initially, the paper was to be driven by DC micro motors that were configured to turn a sprocket. The sprocket is used to transmit rotary motion between two shafts. To change gears and speeds of the bicycle, the diameter of the sprocket needs to be changed. Instead of having multiple sized sprockets in parallel, the initial idea was to place multiple micro motors in parallel to increase the amount of current supplied to the sprocket for more output power. This system seemed to be over complicated and the micro motors would not supply enough power and torque to support a bicycle at high speeds. It was settled that the best solution in driving the bike is with an electric DC motor; thus, creating an electric bike.

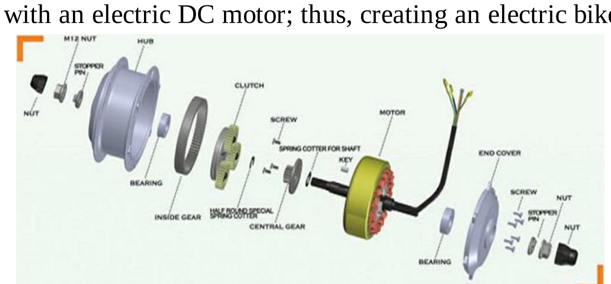

Fig 2: BLDC Schematic

C. Motor Controller

There are two distinct types of controllers designed to match either brushed or brushless motors. Brushless motors are becoming more common as the cost of controllers continues to decrease.

E-bikes require high initial torque and therefore models that use brushless motors typically have Hall sensor commutation for speed and angle measurement. An electronic controller provides assistance as a function of the sensor inputs, the vehicle speed and the required force. The controllers generally allow input by means of potentiometer or Hall Effect twist grip (or thumb-operated lever throttle), closed-loop speed control for precise speed regulation, protection logic for over-voltage, over-current and thermal protection. Bikes with a pedal assist function typically have a disc on the crank shaft featuring a ring of magnets coupled with a Hall sensor giving rise to a series of pulses, the frequency of which is proportional to pedaling speed. The controller uses pulse width modulation to regulate the power to the motor. Sometimes support is provided for regenerative braking but infrequent braking and the low mass of bicycles limits recovered energy. An implementation is described in an application note for a 200 W, 24 V Brushless DC (BLDC) motor.[44]

Controllers for brushed motors: Brushed motors are also used in e-bikes but are becoming less common due to their intrinsic lower efficiency. Controllers for brushed motors however are much simpler and cheaper due to the fact they don't require hall sensor feedback and are typically designed to be open-loop controllers. Some controllers can handle multiple voltages.

To drive and control the BLDC motor, the use of a motor controller was implemented. The motor controller is an essential device for any motor driven device. The motor controller is analogous to the human brain, processing information and feeding it back to the end user. Of course, the applications of a motor controller vary based on the task that it will be performing. One of the simplest applications is a basic switch to supply power to the motor, thus making the motor run. As one utilizes more features in the motor, the complexity of the motor controller increases.

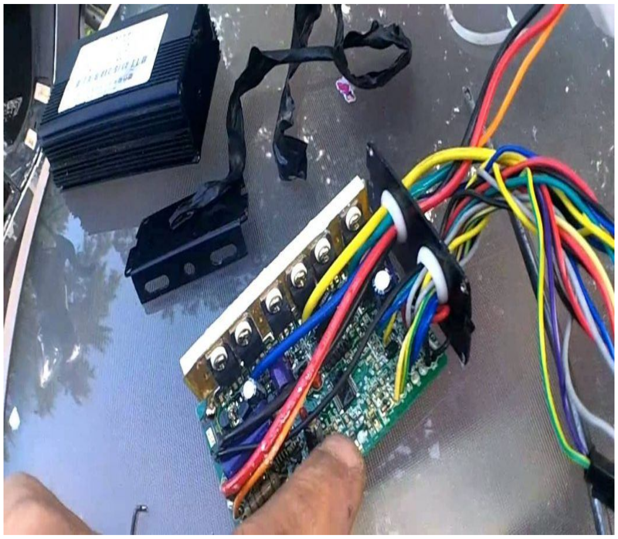

Fig 3: Motor Controller of E- bicycle

To drive the BLDC motor, the motor controller sends rectangular/trapezoidal voltage stokes that are coupled with the position of the rotor, high capacity lithium ion The power stage of the BLDC motor uses six transistors in order to switch on and off the signals that are being delivered to each individual phase of the motor. Any timing offset will ruin the timing of the voltage strokes, thus running the motor less than the maximum efficiency. Figure 4.3 below shows the circuitry in the motor controller.

D. Throttle

Many ebike throttles also come with buttons that can be used to control different functions. The most common is an on/off button to start your ebike. These buttons can also be used for things like lights and cruise control, assuming your ebike supports these features. Some throttles have momentary contact buttons that only work when the button is held down. These types of buttons are better for features like horns or regenerative braking, something you'd want temporarily and only for as long as the button is pressed.

Some throttles come with key switches that can be used to start the ebike. This is a convenient way to add some extra security to your ebike. The extra security is largely superficial, as anyone with a pair of wire cutters could easily "hotwire" your ebike by shorting the throttle wires to by pass your switch. In this case, the security is more against some idiot trying to turn your ebike on while you've left it parked. Either way, it's still one more line of defense, and makes your ebike look just a little less desirable to potential thieves.

Full twist throttles are sort of the antithesis of thumb throttles as they are the largest type of ebike throttle and require the whole hand to operate. The full twist throttle takes up the entire end of the handlebar, completely replacing whatever grip would originally be on the end of handlebar. To operate it, the rider simply grabs a handful of throttle and twist it back towards himself.

Anyone who has ridden a motorcycle or moped will find the full twist throttle familiar. It operates just like the throttle on most motorcycles. Many people prefer full twist throttles because they are operated by the full hand – all five fingers grip that sucker. That allows you to hold on tight, handle well and use your wrist instead of your thumb to apply the twisting motion.

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Volume 6 Issue V, May 2018- Available at www.ijraset.com

Fig 4: Throttle of E- Bicycle

E. Batteries

lead acid batteries for ebike use, you'll generally be looking for what's called a "sealed lead acid" or SLA battery. SLAs come sealed in a hard plastic case and can be turned in any orientation safely without leaking acid. This makes them appropriate for ebike use. Wet cell lead acid batteries, like many car batteries, would leak dangerous acid if turned on their side or upside down, making them a bad idea for use on an electric bicycle, which is a lot more likely to get knocked over than a car. Remember to stick with SLAs – not wet cell lead acid batteries – for electric bicycle use. Lead acid batteries are much larger and heavier than lithium batteries, limiting their placement on ebikes. They almost never come packaged with ebike specific mounting hardware which means that they generally have to go in a bag on the rear rack or in panniers on either side if the rear wheel. Mounting them up high on the rack isn't a good idea either because it will negatively affect handling. Generally speaking, you want to mount your batteries as low as possible to keep the center of gravity of the ebike lower towards the ground. This will significantly improve your ebike's handling. The biggest advantage of lead acid batteries is their price: dirt cheap. Lead acid batteries can be purchased from many different online retailers and local stores. Purchasing SLAs locally helps save on shipping and makes them even cheaper. Many hardware and electronic stores carry them. Even Radioshack has them, though you'll pay more there. Another advantage of lead acid batteries is their high power output potential. Lithium batteries generally don't like to handle too much current. SLAs, on the other hand, can provide huge amounts of current. If you are planning a very high power electric bicycles, SLAs might be a good option for you.

Fig 5: Lead Acid batteries

F. Dynamo

The electric dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through Faraday's law of induction. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. Due to Faraday's law of induction the motion of the wire within the magnetic field creates an electromotive force which pushes on the electrons in the metal, creating an electric current in the wire. On small machines the constant magnetic field may be provided by one or more permanent magnets; larger machines have the constant magnetic field provided by one or more electromagnets, which are usually called field coils.

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Fig 6: Dynamo

IV. MOUNTING CONSTRUCTION

A. Battery Indicator

A Battery indicator is a device which gives information about a battery. This will usually be a visual indication of the battery's state of charge. It is particularly important in the case of a battery electric vehicle.

Fig 7 : Battery Indicator

B. Battery Charger

The charging protocol (how much voltage or current for how long, and what to do when charging is complete, for instance) depends on the size and type of the battery being charged. Some battery types have high tolerance for overcharging (i.e., continued charging after the battery has been fully charged) and can be recharged by connection to a constant voltage source or a constant current source, depending on battery type. Simple chargers of this type must be manually disconnected at the end of the charge cycle, and some battery types absolutely require, or may use a timer, to cut off charging current at some fixed time, approximately when charging is complete. Other battery types cannot withstand over-charging, being damaged (reduced capacity, reduced lifetime) or overheating or even exploding. The charger may have temperature or voltage sensing circuits and a microprocessor controller to safely adjust the charging current and voltage, determine the state of charge, and cut off at the end of charge.

A trickle charger provides a relatively small amount of current, only enough to counteract self-discharge of a battery that is idle for a long time. Slow battery chargers may take several hours to complete a charge. High-rate chargers may restore most capacity much faster, but high rate chargers can be more than some battery types can tolerate. Such batteries require active monitoring of the battery to protect it from overcharging. Electric vehicles ideally need high-rate chargers. For public access, installation of such chargers and the distribution support for them is an issue in the proposed adoption of electric cars.

Lead acid batteries should be charged in three stages, which are [1] constant-current charge, [2] topping charge and [3] float charge. The constant-current charge applies the bulk of the charge and takes up roughly half of the required charge time; the topping charge continues at a lower charge current and provides saturation, and the float charge compensates for theloss caused by self-discharge.

During the constant-current charge, the battery charges to about 70 percent in 5–8 hours; the remaining 30 percent is filled with the slower topping charge that lasts another 7–10 hours. The topping charge is essential for the well-being of the battery and can be compared to a little rest after a good meal. If continually deprived, the battery will eventually lose the ability to accept a full charge and the performance will decrease due to sulfation . The float charge in the third stage maintains the battery at full charge. Figure 1 illustrates these three stages.

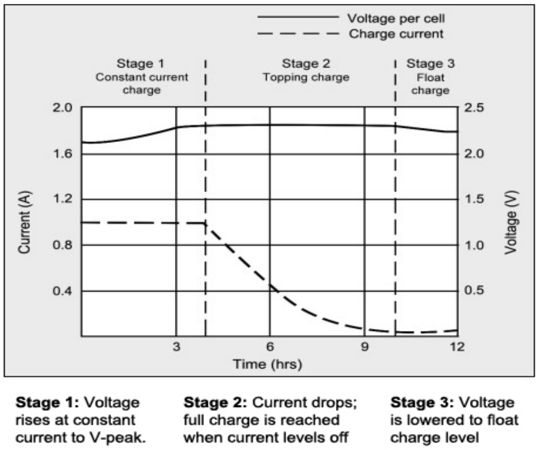

Fig 8: Stages of charge for Lead acid battery

Using the construction parts, the Power E bicycle shown in fig 9 is developed. The bicycle runs with a speed of 30 Km/h. It has two modes of operation: battery mode where the bicycle runs with battery and regeneration mode where the bicycle runs with dynamo. The performance of bicycle is observed to be efficient and it will suit to all age groups.

Fig 9: Power E bicycle

V. CONCLUSION

This paper brought together several components and ideas to achieve a common goal to prove that it is possible to build a bicycle with 2 separate charging sources. We put a lot of time into this bicycle to make sure that it was performing the best it possibly could. Now that the paper as a whole is finished, we hand it over to future generations to design and improve each component.

There are multiple opportunities with this paper and we hope that within a few years, this bicycle can become very efficient and marketable.

We understood that this bicycle can be intimidating because of its weight and its ability to go 30 mph, but whoever takes it on in the future, we ask that you have an open mind and an open heart. This bicycle has become very special to all of us, and we hope that it will be well taken care of and improved upon. Good luck to the future recipients and remember to have fun riding it.

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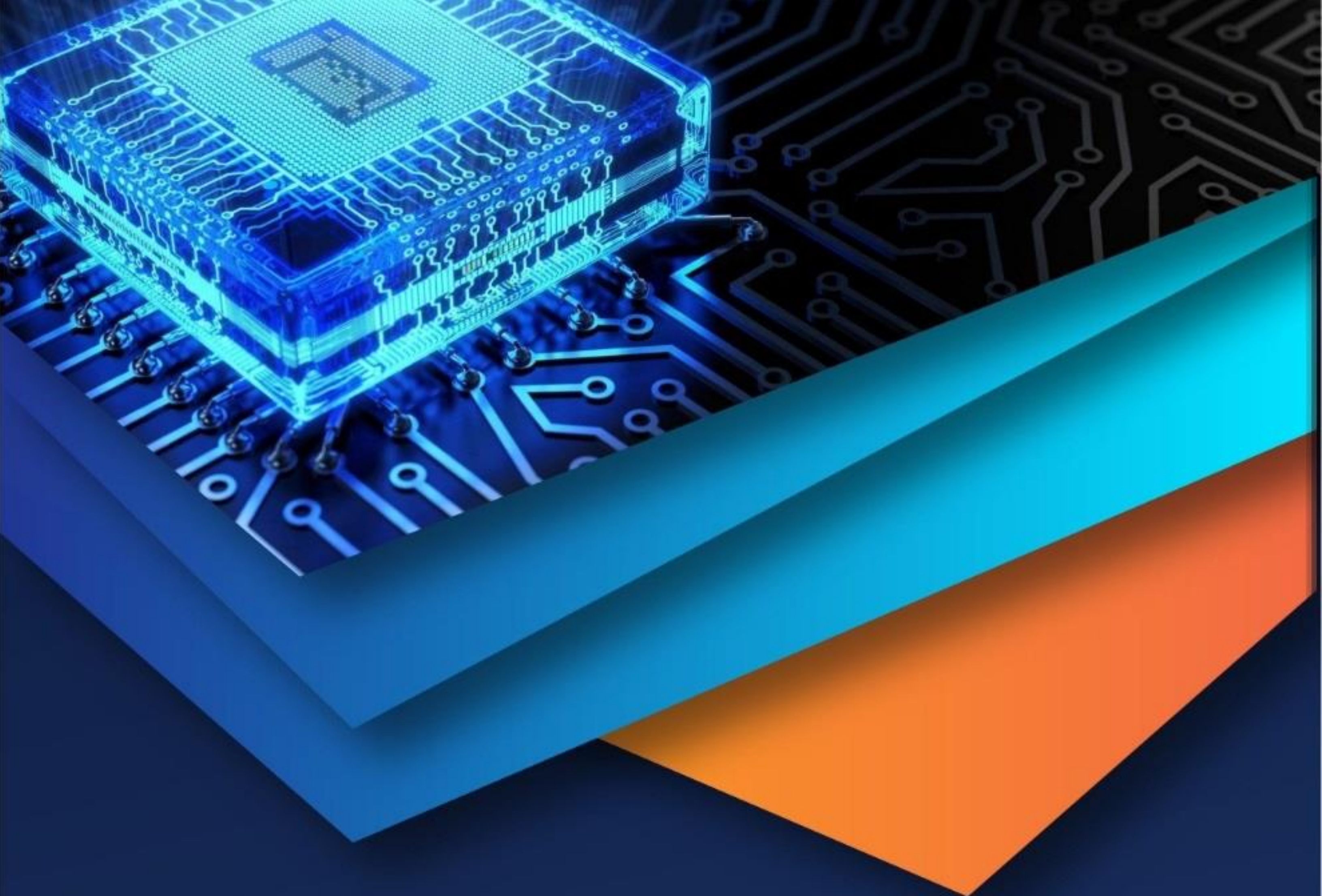

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