Free Energy Electric Bicycle

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***Abstract*— The Electric Bicycle System incorporates three different ways of charging a lithium-ion battery: using dynamo, regenerative braking, and solar power; which is used to power an electric hub motor running a bicycle. The purpose of the project is to show that it is possible and relatively simple, to build an electric bicycle by oneself. This project can be broken down into five separate categories: the lithium-ion battery, the DC-DC boost converter, the solar panel, the motor, and the motor controller. Each of these will be built upon and improved further in future. The hope 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.**

Keywords—Electric Bicycle, Harnessing, solar energy, Economical, Electricity

1. INTRODUCTION

The electric bicycle offers a cleaner alternative to travel short-to-moderate distances rather than driving a gasoline-powered car. In recent years, India has increasingly encouraged a cleaner environment and less dependence on foreign oil. 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 project 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 3 separate ways: through the 120V AC wall source, by generating power through the pedals of the bicycle, and by solar-cell generative power. 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.

2. ELECTRIC BICYCLE

A. Main principle

It works on the principle that the electromotive force of an A.C. motor which receives electrical energy stored in D.C. battery is converted with the help of D.C. to A.C. converter.

B. Methodology

The basis of this project is to construct a system for an electric bike. There are many key components within the block diagram for this system. They consist of a lithium-ion battery, a motor controller, a DC-DC converter, a photo-voltaic solar panel, and a brushless DC motor. The power brakes 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.

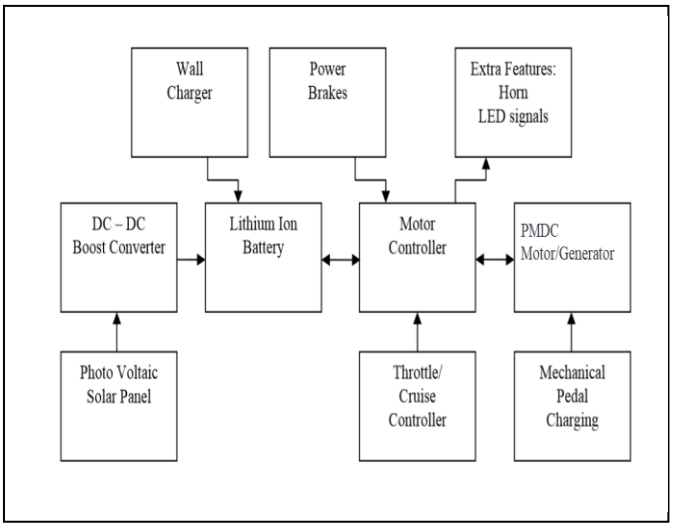

Fig 1: Block Diagram Of Entire Project

3. OPERATION

The power source for the system was a DC battery source chosen to output 48V. The battery was primarily chosen due to the lithium ion cells used to configure it. A lithium ion 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. Lithium ion batteries can be very dangerous; therefore it is essential to research the quality of the lithium ion cells and the protective implementations used. The Golden Motor battery has a high voltage rating diode at the output, and uses it as a current protector. This is essential to the project requirement for interfacing multiple forms of charging such as solar energy, 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 lithium ion battery. These functions are beneficial to the success of this project and also provide a solution to any troubleshooting and damages that may occur.

One key feature that is integrated with the interface of the controller and the motor was the regenerative braking. A regenerative brake is an energy recovery mechanism that reduces the bicycle's speed by converting some of its kinetic energy into a useful form of energy instead of dissipating it as heat from conventional brake friction. The energy is then supplied back to the power source. 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. By creating a switch that purposely is "fooling" the controller to use the motor as a generator without completely braking the wheel, it is possible to generate mechanical energy through pedaling.

Another source of battery charging comes from the photovoltaic solar panel. Initially a light-weight and flexible solar panel was desired. Once a voltage and current is generated through the solar panel a DC – DC boost converter block is needed to step the output voltage from the solar panel to match the battery's voltage of 24V. The power must be conserved in a converter therefore, as the voltage in increased, the current is decreased. It is more efficient to have a higher current input to the boost converter but for the current budget and resources, it is not practical. Due to the inefficient charging power supplied to the battery, it is not realistic for the solar panel to fully charge the battery. Its primary purpose is to provide a longer life cycle for the battery and to provide some charge when access to an outlet is not available.

4. WORKING

The function of the dynamo is to convert the mechanical energy into electrical energy. Dynamo is fitted in the bicycle. It is in contact with the wheel. When the wheel rotates, dynamo is functioning. Dynamo is connected with the battery. The battery is charged by means of dynamo. The battery contains two terminals. One is the positive terminal and another one is the negative terminal. The wire connections were made for the flow of electrons from one part to another part. When the motor energies through the current, the stator field coil get magnetized and induces the rotor shaft to rotate in the counter clockwise direction. Motor shaft is connected with the shaft of rear wheel, thereby transmitting power to the wheel. So the bicycle moves in forward direction. Whenever bicycle is running, the above mentioned processes are continuously going on.

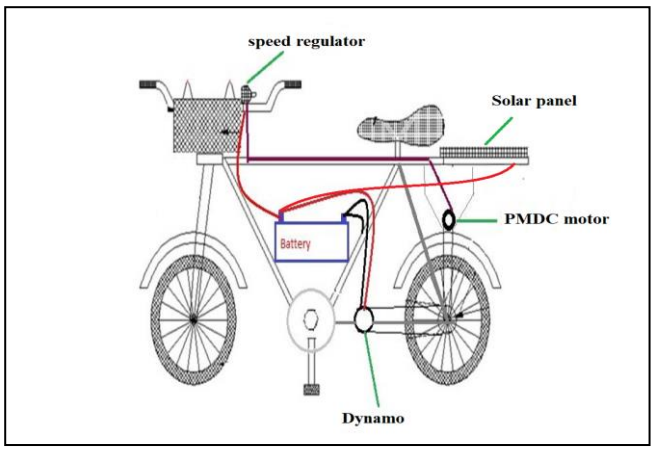

Fig 2: Schematic Diagram

DC motors are used extensively in adjustable-speed drives and position control applications. Their speeds below the base speed can be controlled by armature-voltage control. Speeds above the base speed are obtained by field-flux control. As speed control method for DC motors are simpler and less expensive than those for the AC motors, DC motors are preferred where wide speed range control is required.

5. COMPONENTS OF E-BICYCLE

1) *PMDC Motor:*

The rotor is slotted armature which carries armature winding. Rotor is made from layers of laminated silicon steel to reduce eddy current losses. Ends of armature winding are connected to commutator segments on which the brushes rest. Commutator is made from copper and brushes are usually made from carbon or graphite. DC supply is applied across these brushes. The commutator is in segmented form to achieve unidirectional torque. The reversal of direction can be easily achieved by reversing polarity of the applied voltage.

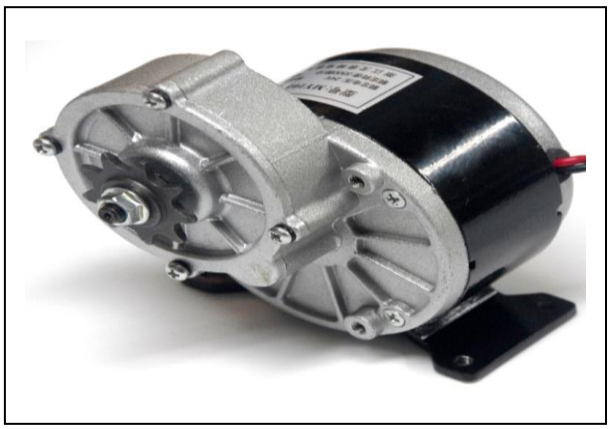

Fig 3: PMDC Motor With Torque Controller

2) *Gear Trains:*

Gear trains, belt drive and chain drive are the power transmission element. Here, chain drives are used in power

transmission. The major components of the chain drives are sprocket and chains.

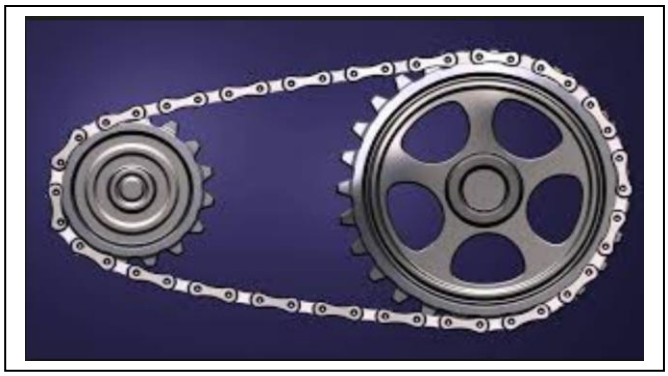

Fig 4:Chain Sprocket

3) Solar Panel:

Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. A photovoltaic (PV) module is a packaged, connected assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W). The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. There are a few commercially available solar modules that exceed efficiency of 24%.

4) Dynamo:

Dynamo is a device which converts mechanical energy into electrical energy. The commutator was needed to produce direct current. When a loop of wire rotates in a magnetic field, the potential induced in it reverses with each half turn, generating an alternating current. However, in the early days of electric experimentation, alternating current generally had no known use. The few uses for electricity, such as electroplating, used direct current provided by messy liquid batteries. The commutator is essentially a rotary switch. It consists of a set of contacts mounted on the machine's shaft, combined with graphite-block stationary contacts, called "brushes", because the earliest such fixed contacts were metal brushes. The commutator reverses the connection of the windings to the external circuit when the potential reverses, so instead of alternating current, a pulsing direct current is produced. It would probably be more practical to design a free energy recharger for the batteries that is not attached to the bicycle, and design our bike to operate on a small electric motor that uses the rechargeable batteries. This arrangement would be easy to do, as free energy battery rechargers are commonly.

Fig 5: Dynamo

5) Battery:

The battery also acts as a condenser in a way that it stores the electric energy produced by the generator due to electrochemical transformation and supply it on demand. Battery is also known as an accumulator of electric charge. This happens usually while starting the system.

6) Braking System:

For the braking system it is convenient to use braking system used in regenerative brake system which consist of spring loaded friction- shoe mechanism, which is driven with the help of hand lever.

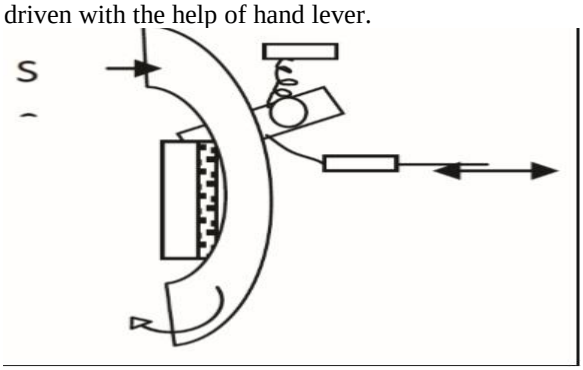

Fig 6: Braking System

7) DC-DC Boost Converter:

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage from its input to its output. It is a class of switched-mode power supply containing at least two semiconductors and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors are normally added to such a converter's output. Power for the boost converter can come from any suitable DC sources, such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage. Since power (P=VI) must be conserved, the output current is lower than the source current.

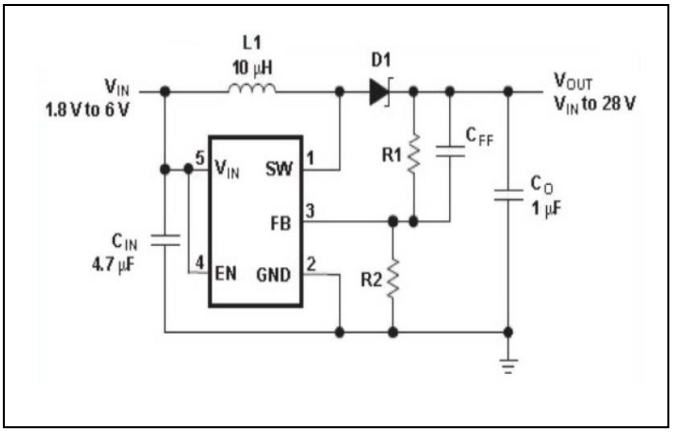

Fig 6: DC-DC Boost Converter

LITERATURE SURVEY

The idea of a motorized bicycle, let alone the electric powered bike, it is not a recent concept and has been around for more than a century. In 1867, the first non motor bike was invented by Sylvester Howard Roper of Boston, MA. His innovative approach to the bicycle would be commercially known as the Roper steam velocipede, which was basically a bike powered by a steam engine. Although the use was around for a while during those times, it wasn't until 1895 that the electric bicycle made its place in history. The Ogden Bolten designed using 6 pole brush and commuter DC hub motor connected to the rear wheel. He was then granted a US patent. Couple of years later, Hosea W. Libbey invented electric bike which was propelled by double electric motor. This motor was so designed that it was attached with the crank set axle. Later in 1990's torque sensors and power controls were developed including some modified versions of bike with NiMH, NiCd and/or Li-ion batteries which offered lighter, density capacities batteries. As the year progresses, more and more electric bikes were produced with varying driving mechanisms. Some had a motor connected to the wheel with a belt or chain. It was the patent of Albert Parcelle of Boston,MA. By the year 1992, there were still hardly any commercial electric bicycles available.

K.VIGNESH et.al [2015] [1]: In this paper "Free energy bicycle" where the bicycle is made to run using dynamo.

S.B BARVE et.al [2016] [2]: In their paper "Design and development of solar hybrid bicycle" two or more photovoltaic cells may be used to harness solar energy to generate voltage to charge the battery.

Today, we are planning to continue on with the concept of electric bike and look for new ways of making a more efficient and practical electrical bike. In our project we design an electric bicycle which uses zero external power supply and runs using various energy sources like solar, dynamo, energy regenerated during braking etc.

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RESULT

1. Bicycle that utilizes renewable energy from various sources
2. Kinetic energy of bicycle is converted to electrical energy using dynamo
3. These energy is used to run the bicycle

CONCLUSION

This project brought together several components and ideas to achieve a common goal: to prove that it is possible to build a bicycle with 3 separate charging sources. We put a lot of time into this bicycle to make sure that it was perform best it possibly could. Now that the project as a whole is finished, we hand it over to future generations to design and improve each component. Possibly future projects may include:

1) Design of a charge controller for the battery: The battery management system (BMS) built within the battery was very hard to access, so we couldn't get an idea of how it was designed. Having a BMS with the ability to take in a wider range of voltages and currents will be ideal.

2) Design of the motor controller: The current motor controller is a very nice size and weight, but the connections that it provides are not as stable and protected as it can be. Limiting the amount of wiring and connections may also be desired.

3) Construction of a separate hub motor: There are many levels to the design of the 48V, 1000W motor can be placed on the front wheel of the bicycle or it can just be used to compare the speeds and efficiencies to the current motor on the bicycle

4) Design of a more effective boost converter: The current boost converter provides only 3mA from the solar panel to charge the battery. That would take about 4000 hours to fully charge the battery from an empty charge. The design of a new also be able to provide a higher current will be beneficial to the life of the b single charge will last.

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