JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Enhanced Energy Optimization System of EV Bicycle

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Abstract: In India, the demand for electric motor bicycles is rising since they use less energy, produce less noise, and require less maintenance. The goal of this research project is to create a basic, affordable electric motor model. A bicycle equipped with an intelligent controller. The motor, battery, and controller are the three components of the electric motor bicycle. This unique wheel's rim holds a fixed BLDC motor. To regulate the motor's speed and current, the controller is connected to the battery and motor. The electric motor bicycle can be powered by pedaling or by a battery charge. The simulation results were produced by ELECTRIC BIKE SIMULATOR. The hardware assembly kit also displays the experiment findings.

Keywords: EV Bicycle, Electric Motor, Battery, BLDC Motor, and Electric Bike Simulator

I. INTRODUCTION

1.1. General Introduction

The term "electric vehicle" refers to a vehicle that is propelled by one or more electric motors or traction motors (EVs). A self-contained electric vehicle can convert gasoline to energy using a battery, solar panels, fuel cells, or an electric generator, or it can be powered by electricity from off-vehicle sources using a collector system.[1] EV Cycle is an electric and power-assisted bicycle that is one of the bicycle industry's fastest-growing technologies. This bicycle has an electric motor to assist you in moving forward. As a result, you can ride it like a regular bicycle while exerting less effort. An E-Cycle motor works by turning on automatically when you peddle or throttle. There are two main types of E-Cycle

- Throttle assist
- Pedal assist

1.2. Classificationof Electric Bicycle

Types of E-Bikes: They are classified into three types[2]

1.2.1. 1.2.1 TYPE 1 E-Bicycle

An electric bicycle with Pedal Assist requires you to pedal to run the motor. It looks like an ordinary bicycle except that it contains a motor that recognizes when you're pedaling and assists you. It's as though you've always had a strong tailwind behind you. This class/type of E-bike may or may not have a throttle.

1.2.2. TYPE 2 E-Bicycle

Throttle Only is a throttle-controlled electric bicycle. These electrics do not require pedaling to benefit from the motor. You'll be on your way in no time if you simply push the throttle. Accelerating in the middle of a corner will allow you to gain more traction. Naturally, the less you cycle, the faster the battery drains.

1.2.3. TYPE 3 E-Bicycle

With Pedal Assist, you can go up to 28 mph. This Class/Type is the fastest "legal" E-bike, with a top speed of 28 mph. It is still deemed a "bicycle," and no driver's license, license plate, or other documentation is required. It's technically a bicycle, and it's a lot of fun! Helmets are required by law. his category is best for someone who rides their bike to work.

1.3. Advantages of E-Bicycle

- An E-bike is an environmentally friendly bicycle. It's the same as our regular bicycle. E-Cycle, on the other hand, is powered by electricity rather than gasoline. No harmful emissions are emitted into the atmosphere. For the same reason, electric bikes don't produce any additional noise.[3]
- Electric bicycles, in general, do not require any maintenance. Lubricate the drive system and inspect the chain and wheels on a regular basis to keep it clean.
- Riding an electric bike is fashionable and popular right now. It's also the most efficient approach to cut down on pollution.

1.4. Objective

- To create an efficient E-cycle that can be used on many types of roadways.
- To adapt the E-cycle to various requirements.[4]

• To design an E-cycle using the 3Rs (Reduce, Reuse, and recycle).
Reduce: Electric cycle can reduce emissions.
Reuse: The cycle can be reused from old conditions.
Recycle: The cycle has been recycled from scrap condition.

II. DESIGN OF ELECTRIC MOTOR BICYCLE

Here the current from the battery moves to the controller where all the connections are made. When the power is given to the motor, it rotates the wheel using a chain and sprocket.

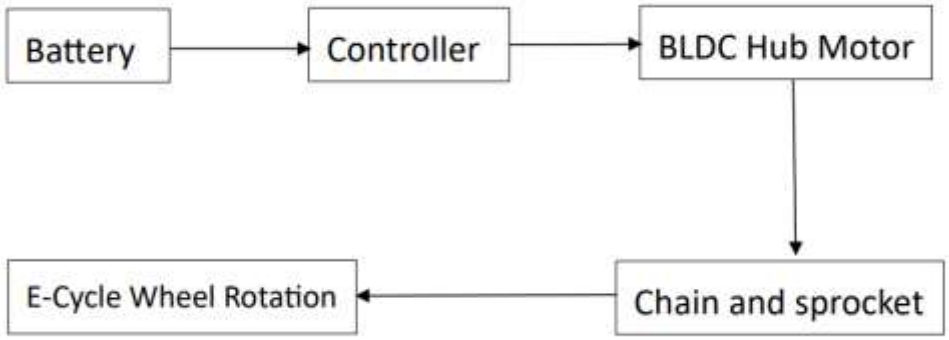

Fig.1 Block diagram of Electric Bicycle

2.1. HowTo Turn onan Electric Motor Bicycle

Insert the key and turn on the ignition. Long press the power button in the instrument console, then the power supply will be active.

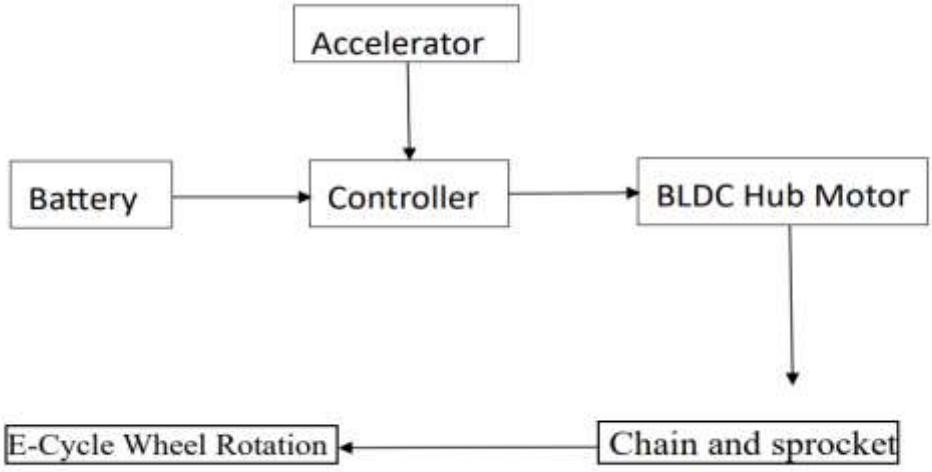

Fig.2 Block diagram of converting Electric Bicycle

When we rotate the accelerator to our desired amount, the controller takes the input gives the limited power to the motor, and runs accordingly.

2.2. WorkingofAuto-Cut-Off Brakes

When the brakes are applied during running/idle conditions, the controller cuts off the power supply to the motor till the brakes are engaged.

Working of cruise control: When the E-cycle is running under a constant speed for 5 sec, the bike is changed to cruise mode and maintains the same speed. To change back to normal mode, you can accelerate or slightly engage the brake.

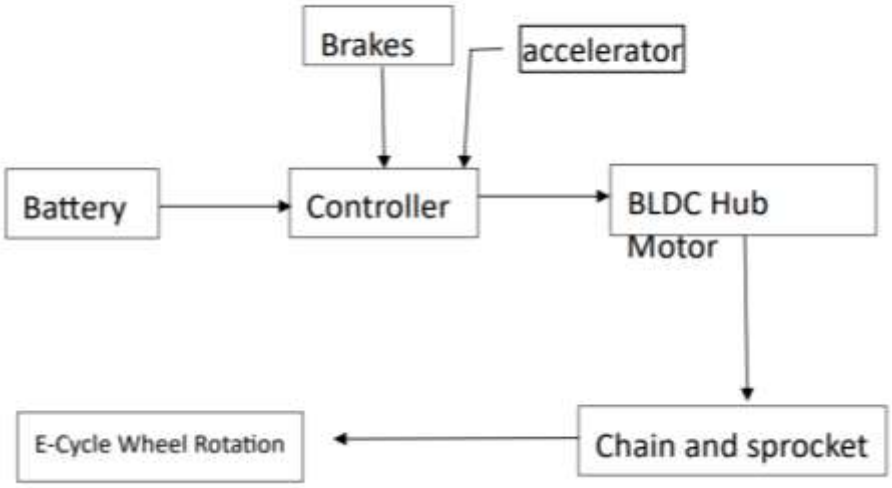

Fig.3 Block diagram for auto cut-off brakes

2.3. Working of Instrument Cluster

The instrument console displays speed, battery level, and odometer. It has three buttons (power button, motor power up button, and motor power down button). The power button has two functions, long press - for turning on ignition. Short press - for toggling between voltage level, trip meter, and odometer.

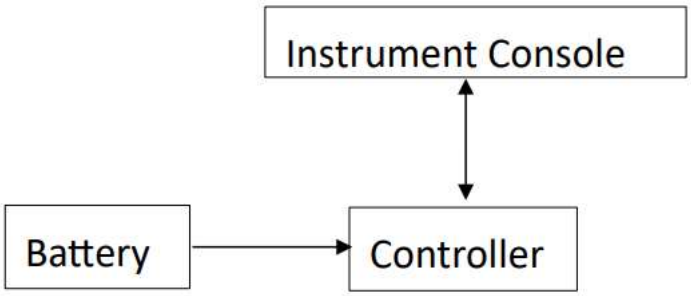

Fig.4 Block diagram for the instrument cluster

III. SELECTION OF COMPONENTS

3.1 DC Hub Motor (BLDC)

A brushless DC (BLDC) motor with permanent magnets is used in this system. In a BLDC motor, which is a type of synchronous motor, the magnetic fields generated by the stator and rotor have the same frequency. The BLDC motor lasts longer since it does not require brushes. It also boasts a high starting torque, a fast no-load speed, and low energy losses. Three-phase motors are the most common and commonly utilized in e-bikes out of a variety of layouts. Because the motor replaces the wheel hub, the system is chosen with a hub motor. Coupling loss is decreased, and mounting is simple without the use of chains or belts, resulting in a smaller and lighter.[5]

3.2. Controller

One of the most crucial components of an electric bike is the electric bike controller; it is the e-brain that controls the motor's speed, start, and stop. It's connected to everything else inthe car, including the battery, motor, throttle (accelerator), display (speedometer), PAS, and any other speed sensors.

3.3. Battery

Compared to other high-quality rechargeable battery technologies, Li-ion batteries provide several benefits (nickel-cadmium or nickel-metal hydride). They have one of the highest energy densities of any battery technology available today (100-265 Wh/kg or 250-670 Wh/L). Li-ion battery cells can also deliver 3.6 volts, which is three times higher than Ni-Cd or 26 Ni-MH technology. This means they can supply a lot of current for high-power applications, which is a good thing. Li-ion batteries are also low-maintenance, as they don't need to be cycled regularly to keep their life.[6]

3.4.Instrument Cluster

We're utilizing a cluster to show how much the battery is charging and how fast the bicycle is going. The instrument cluster is an important aspect of every vehicle because it is the vehicle's face that displays its current state.[7] It can provide critical signals of electrical component faults (EFI/ISG related) in addition to basic vehicle information. Clusters can collect vehicle data using simple technologies like encoders as well as more complicated interfaces like CAN, SAEJ1850, and so on.

Fig.5 Display

3.5 Throttle

The throttle mode works similarly to that of a motorbike or scooter. You can propel the bike forward without pedalling by pressing the throttle. You can control how much power is produced with most throttles.[8]

Fig.6 Throttle

Different Types of Throttles on Electric Bikes

Half-grip Twist

Thumb Throttle

3.6. Light

These LED lights are long-lasting, simple to operate, and energy-efficient. The lights on offer are placed in electric bikes and create a bright dazzle of light in the evenings when there isn't enough light. Its one-of-a-kind lens design allows light to pass through the light cup before forming the whole reflection. This results in a more effective light beam and less light energy loss.[9]

Fig.7 Light

3.7. Horn

A horn is a device that consists of a tube, usually made of metal and curved in a number of ways, with one tiny end into which the musician blows and one large end from which sound emerges. The bore of a horn, unlike that of some other bass instruments, such as the trumpet, gradually widens over its length, making it conical rather than cylindrical. In jazz and popular music, the term "horn" refers to any wind instrument, and a horn section is made up of brass or woodwind instruments, or a combination of the two.

Fig.8 Horn

3.8. BMS

The battery management system is in place to keep track of each battery cell's specific performance. Rather of allowing for individual performance, the BMS assures that each battery cell drains, performs, and acts in the same way as every other cell in the battery. [10]

Manage BMS System:

- Don't charge your battery with a charger that isn't rated for it.
- Never leave your battery in a hot, cold, or wet environment.
- After Long Periods of Inactivity, Refresh the BMS System

Fig.9 BMS

IV. BATTERY AND BATTERY MANAGEMENT SYSTEM

4.1. Battery Fundamentals

Electric vehicle batteries account for over 90% of battery use in the energy sector.They are typically lithium-ion batteries that are designed for high power-to-weight ratio and energy density. Compared to liquid fuels, most current battery technologies have much lower specific energy. This increases the weight of vehicles or reduces their range.

4.2 Types of Batteries

Batteries:[11]
Lithium-Ion (Li-Ion) Batteries
Lead Acid Batteries
Nickel-Metal Hydride (NiMH) Batteries
Lithium Polymer (LiPo) Batteries
Solid-State Batteries

4.3. Introduction of Battery Management System

A Battery Management System (BMS), which manages the electronics of a rechargeable battery, whether a cell or a battery pack, thus becomes a crucial factor in ensuring electric vehicle safety. It safeguards both the user and the battery by ensuring that the cell operates within its safe operating parameters. BMS monitors the State of Health (SOH) of the battery, collects data, controls environmental factors that affect the cell, and balances them to ensure the same voltage 36 across cells.[12]

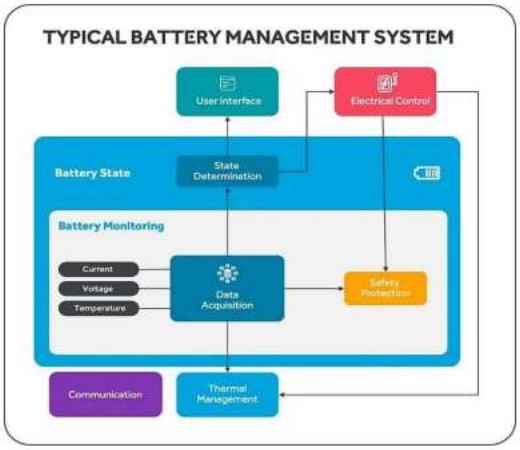

Fig.10 Typical BMS

4.4. BMS Architecture

Battery Management System (BMS) architecture in electric vehicles (EVs) is a crucial componentresponsible for monitoring and managing the performance, health, and safety of the 38 battery pack. The BMS ensures that each cell within the battery pack operates within its safe limits, maximizing the overall efficiency and lifespan of the battery system. The BMS also communicates with the onboard charger to monitor and control the charging of the battery pack. It helps maximize the range of the vehicle by optimally using the amount of energy stored in the battery pack.[13]

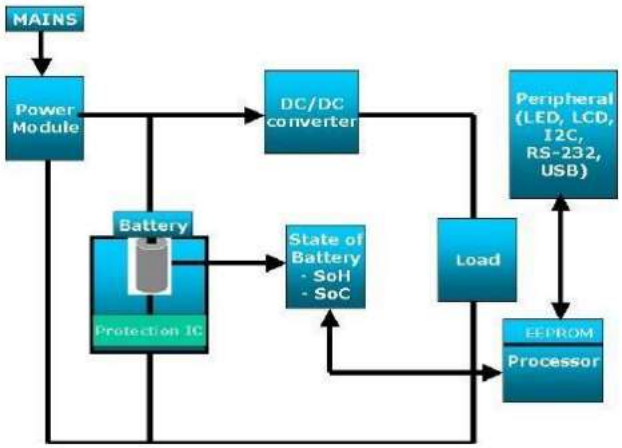

Fig.11 BMS Architecture

4.5 Cell Balancing Technique

Cell balancing is a crucial aspect of managing battery packs in electric vehicles (EVs) to ensure optimal performance, longevity, and safety. Here are some common cells balancing techniques used in EVs[14]

1. Passive Cell Balancing
2. Active Cell Balancing

Fig.12 Cell Balancing

V. CONCLUSION AND FUTURE SCOPE

5.1. Conclusion

rom this project we have done the conversion of scrap cycle to a good condition Ecycle which has almost every feature compared to every cycle in market. It is cost efficient and follows all the 3Rs of the eco system. We got a good lithium-ion battery which gives the range 40km (or even more, depends on the driving conditions.) and a top speed of 30 km/h.

5.2. Future Scope

In future this cycle can be developed and can add additional feature like bidirectional controller which can regenerate battery power by peddling. Since our project has single directional converter but it can't be recharged while riding. So, the regenerative braking system won't be available. We can change to bidirectional converter and add that feature. We can even make an attempt to convert other vehicles like handicapped tricycle and cycle rickshaws.

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