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Booster Bike with Interchangeable Regenerative Front Wheel

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ABSTRACT

The aim of this review paper is to present a close compact system for Electric Vehicles. There are many substitutions available in the market for electric vehicles, but in our revolutionary project we have designed a system consisting of all parts in one compact wheel assembly which is interchangeable and regenerative.This is multi-purpose application wheel as it can be used in hand kart, bicycle, tricycle, stretcher, trolleys, wheel chair for handicapped persons. There will be several charging stations, If battery of wheel is fully discharged then one can easily recharge, interchange or replace it with recharge battery. As pollution is increasing day by day we need substitution of petrol based vehicle which should be economical, eco-friendly, durable, efficient, less time consuming.

Keywords: Electric bike , Compact system, Interchangeable Wheel , BLDC hub motor , Regenerative.

I. INTRODUCTION

An electric bike, also known as an e-bike or booster bike, is a bicycle with an integrated electric motor which can be used for propulsion. In electric bike a motor is used which utilized the DC power supply which is obtain from DC battery. This motor is connected to rear wheel of cycle through chain drive or belt drive.

When the motor is energized it rotate the wheel and forward motion is obtained. The important part is motor which is a driving member mostly a DC motor is used which has brushes through which power supply goes to the winding, the speed of DC motor is not too high. The shape of motor is of cylindrical or pot type is placed on the Frame.

The upgradation in electric cycle is to replace the motor.As we know Dc motor is not too much efficient during heavy working the new concept is bring i.e. BLDC (Brush less DC motor) the name itself indicate that it does not have any brush for transferring current to winding because of this reason it has very high speed as well as give greater torque during running. Also it is more compact and light in weight.

By adding electric motor, battery, regeneration system in a close compact unit, we can reduce required spacewhich will result in smoother, convenient,less strenuous cycling experience and will provide extra boost of power.

II. PROBLEM STATEMENT

As we know that all e-bicycles, electric wheel chair are design in such a way that it required to installed motor in wheel and all separate components like battery, controller at various location of system to make electric system.

Design and fabrication of an electrical wheel which consists all components like motor, battery, controller in itselfthat wheel can be easily attached to any cycle,

wheel chair, and trolley to convert it into electric system.

We can increase efficiency of the bicycle by regeneration system. Also can be recharge by charging station available on highways and roads, while in remote locations solar panels are useful for recharging.

III. OBJECTIVES

- Design a front Wheel.
- Design Regeneration system.
- Design a compact electric wheel.
- Increases fuel efficiency.

IV. WORKING PRINCIPLE

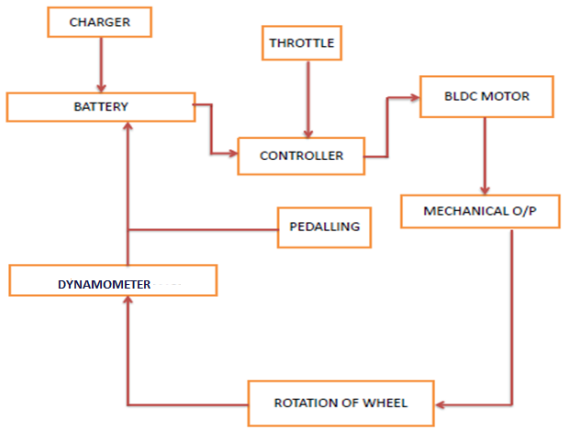

Figure1. Working Principle.

There are many different components shown in a block diagram. The main components are brushless DC motor, motor controller, Li-Ion battery, throttle and dynamo. The power source for this system is given by Li-Ion battery.

The output of Li-Ion battery is 36V. There are multiple forms of charging source is used such as AC voltage through an outlet, dynamo energy and mechanical pedal charging system. The dynamo output is 12V and 20 watt. Once a voltage and current is generated through the dynamo and it give to battery source. Also we use mechanical pedal charging system, so dynamo is use for this charging system. A dynamo is an electrical generator that produces direct current by rotate with wheel. This Li-ion battery block connected with a controller block. So this controller block control the all function of the system.

The controller is to regulate the amount of applied power on brushless DC motor. Also there are many functions for this controller that over current protection, under voltage protection and also throttle are used to control the speed of a brushless dc motor. These functions are beneficial to the system and also provide a solution to any troubleshooting and damages that may occur. Throttle are also connected to the controller by which speed of cycle can regulate.

Figure 2. Working Principle Diagram.

It works on same principle of planetary wheel. Wheel consisting motor and two idler connected by means of frame structure in such a way that they are connected to frame at an angle of 120 degree. Motor and pulley have concave surface it meshes internally with rim having convex surface.

Motor runs on battery by controlling throttle and it rotates to the rim and drive system. Both idler works as support and regeneration of power. Idler is rotated by rim. Alternator is mesh with idler which generates electricity. Structure is stationary and only rim is rotating.

a] BLDC MOTOR

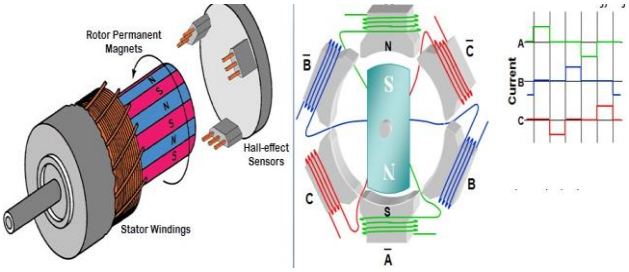

Figure 3. Construction of BLDC Motor.

BLDC motor works on the principle similar to that of a conventional DC motor, i.e., the Lorentz force law which states that whenever a current carrying conductor placed in a magnetic field it experiences a force. As a consequence of reaction force, the magnet will experience an equal and opposite force. In case BLDC motor, the current carrying conductor is stationary while the permanent magnet moves.

ADVANTAGES OF BLDC MOTOR

- It has no mechanical commutator and associated problems.
- High efficiency due to the use of permanent magnet rotor.
- High speed of operation even in loaded and unloaded conditions due to the absence of brushes that limits the speed.
- Smaller motor geometry and lighter in weight than both brushed type DC and induction AC.
- Quite operation (or low noise) due to absence of brushes DC motors.
- Long life as no inspection and maintenance is required for commutator system.
- Higher dynamic response due to low inertia and carrying windings in the stator.
- Less electromagnetic interference.

b] LITHIUM ION BATTERY

Figure 4. Lithium Ion Battery.

Compared to other mature battery technologies, Li-ion offers many benefits. For example, it has excellent specific energy (140 Wh/kg) and energy density, making it ideal for battery electric vehicles. Li-ion batteries are also excellent in retaining energy, with a self-discharge rate (5% per month) that an order of magnitude lower than NiMH batteries. However, Li-ion batteries also have some drawbacks as well.

Comparatively, Li-ion batteries have been a very expensive battery technology. There are also major safety concerns regarding the overcharging and overheating of these batteries. Li-ion can experience a thermal runaway, which can trigger vehicle fires or explosions. There had been serval instances where the Tesla Model S, which utilized Li-ion batteries, had infamously caught on fire due to issues with fluctuating charging or damage to the battery. However, great efforts have been made to help improve the safety of vehicles that use Li-ion batteries.

c] CONTROLLER

The mechanism of an electric speed controller varies depending on whether you own an adaptive or purpose-build electric bike. An adaptive bike includes an electric drive system installed on an ordinary bicycle. A purpose-built bike, more expensive than an adaptive bike, provides easier acceleration and affords more features. The mechanism of electric bike speed controller varies in these two types.

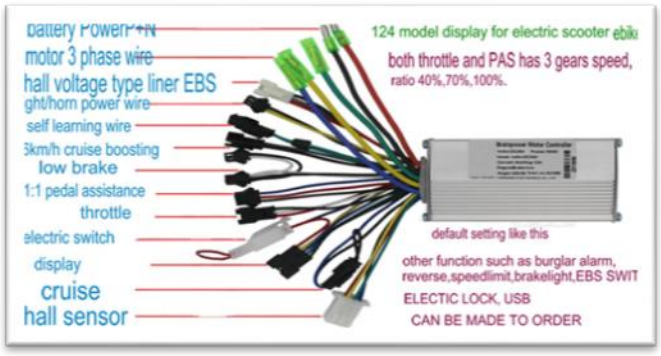

Figure 5. Controller.

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 Function

The electric bike speed controller sends signals to the bike's motor hub in various voltages. These signals detect the direction of a rotor relative to the starter coil. The proper function of a speed control depends on the employment of various mechanisms

d] DYNAMOMETER

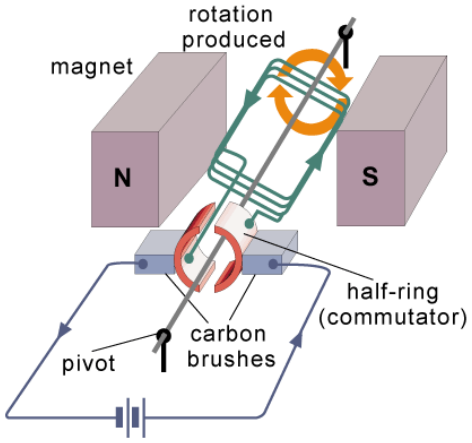

Figure 6. DYNAMOMETER.

It is device which is used to convert the mechanical rotation into electrical energy it works on faraday's law. According to the Faraday's law of Electromagnetic Induction. whenever a conductor moves in a magnetic field EMF gets induced across the conductor. If the close path is provided to the conductor, induced EMF causes current to flow in the circuit.

V. CALCULATION

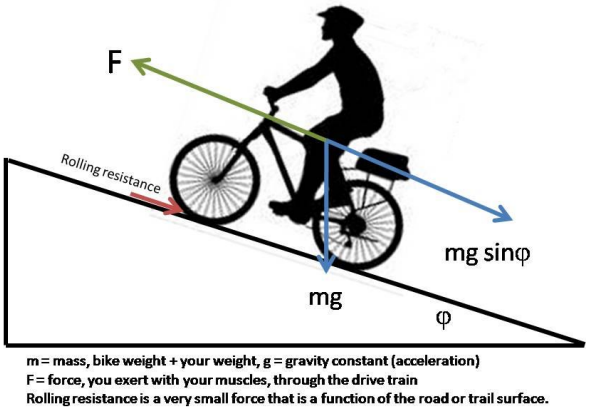

Figure 7. Analysis of propulsion force.

Cycle works on newton 2^{nd} law

Fp - (Fr + Fs + Fw)=M x a

Where,

Fp= Propulsion force

Fr= Rolling resistance force

Fs= Slope resistance force

Fw= Wind resistance force

a = Acceleration of cycle

M= Mass of cycle with Rider

1) To calculates Resistance forces

$Fr=9.81\times M\times Cr\times\cos(\alpha)$

$Fs=9.81\times M\times Cr\times\sin(\alpha)$

$Fw=\frac{C_d\times\rho\times A\times(V_w+V_g)^2}{2}$

Where,

M=Total Mass of cycle in Kg,

α = slope angle in degree,

Cr=Rolling resistance coefficient

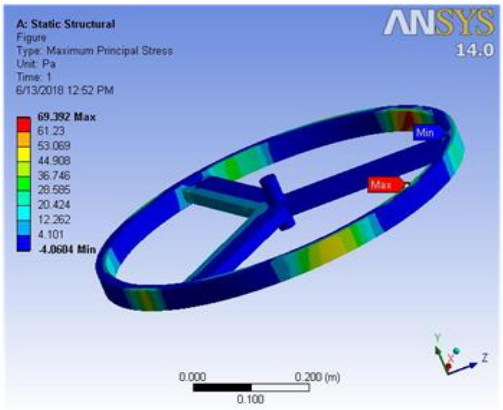

Figure 8. Analysis of Maximum Principle stress.

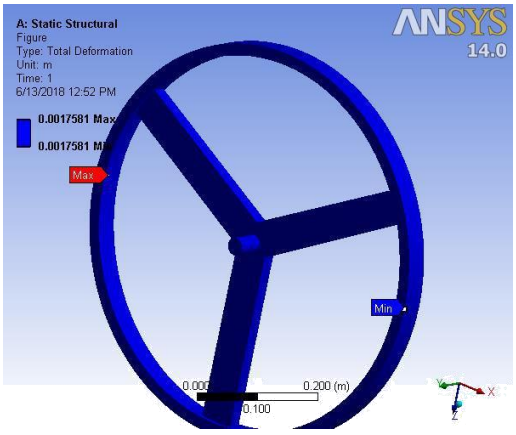

Figure 9. Analysis of Total Deformation

Table 1. Motor Selection Table.

Sr. no.	Rider weight (kg)	Total mass (kg)	Power (W) at $\propto = 5°$	Power (W) $\propto = 30°$
1	55	80	180.24	205.36
2	60	85	193.58	219.29
3	65	90	210.68	230.78
4	70	95	230.38	252.6
5	75	100	251.49	269.5486
6	85	110	270.32	285.35
7	95	120	288.35	310.075

From above table Power selected for motor is 350 watt for better performance at slope with high load.

VI. FUTURE SCOPE

- Solar Panel [Remote area].
- Recharge Stations at road side [solar, wind, tidal].
- Exchange Recharge wheel.
- Increases efficiency [Regenerative System].
- Monowheel.
- Improvising front wheel as unicycle[gyroscopic].

VII. CONCLUSION

In this project concluded that the design and fabricated electrical wheel can be easily attached to any cycle and runs system with high load and impact condition.

From the testing results obtained it is important to point out that the torque of system has increased due to eccentric power transmission from motor to rim. Bicycle is able to climbing gradient easily. Generator are able to generate electricity so that system works as regenerative system.

In the further work, the increased weight will be analysed taking into account. Necessary to focus on amount of weight of wheel to be reduced to make system light weight.

VIII. REFERENCES

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