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Performance Analysis of E-Bicycle Fabricated using Scrap

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***Abstract* – The environment is being drastically affected by the emissions released from vehicles and industries. In response to this, people have been turning to non-polluting mechanized transportation, such as electric power for personal transportation and bicycles. Electric Bicycles have become a popular form of transportation due to their efficiency and cleanliness. These bicycles are produced by combining a bicycle with an electric component. By using an electrical component, the human power used is reduced. Our study intends to provide insight into the environmental impact of electric bicycles. The necessary components of an electric bicycle are a Bicycle, Battery, DC Converter, Controller, and BLDC motor.**

***Keywords* – Bicycle, Battery, DC-Converter, Controller, BLDC motor**

I. Introduction

The incredible range of uses for electric bicycles and regular bicycles alike is impressive. For some, they are used as a tool to make a living or as a form of transportation that is more environmentally friendly. For others, they are just for recreation and a way to explore the world around them. With more than one billion bicycles in existence today and a prediction that there will be 40 million electric bikes by 2023, it is astounding to observe how far electric bikes have come and the places they can take us [1]. The very first electric bicycles were documented in the 1880's and 1890's in records from France and the U.S. In France, one of the earliest was a three-wheel electric vehicle with a hand-held lever system instead of pedals. In the United States, Ogden Bolton Jr. was issued a patent in 1895 for a battery-powered bike that had a hub motor mounted in the rear wheel and a battery in the frame, resembling some modern electric bicycles. As time went on, more designs and bikes came up, laying the foundation for current machines. In 1897, Hosea W. Libbey of Boston created an electric bicycle powered by a "double electric motor" in the hub of the crank axle. This design is similar to the mid-drive motors used on some bikes today [2]. By the middle of the 20th century, mass production of electric bicycles had started to appear. Europe was one of the first areas in which adoption of these bikes was seen in larger numbers with higher production rates and increased usage. One of the initial models to be produced was the 1932 Phillips Simplex Electric Bike, which was a collaborative effort between Philips and Simplex shown in figure-1 [3].

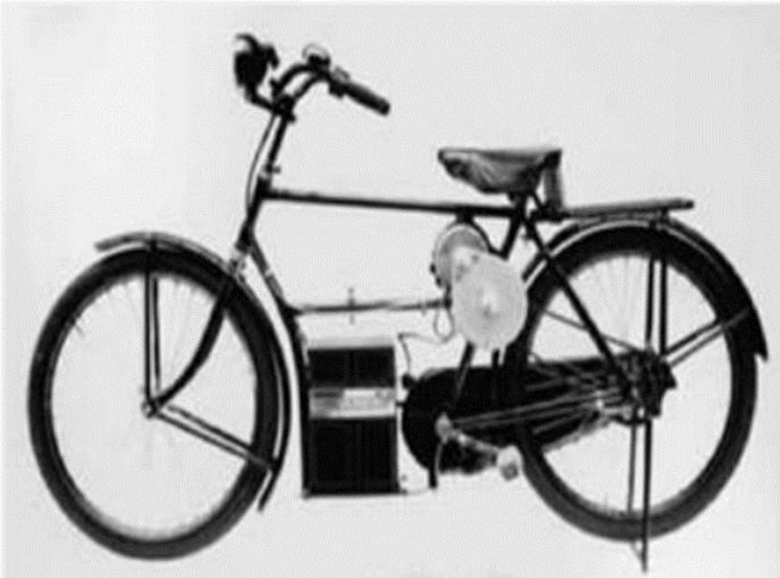

Fig.1 Phillips Simplex, 1932 [1]

In 1989, Michael Kutter developed the first Pedal Electric Cycle (now known as pedal-assist) which allowed riders to utilize an electric bike in a similar way to a regular bike, as the motor power was triggered by pedalling action. Kutter upgraded a few of his own bikes with the Pedelec system, and then assisted Velocity Company in creating the 1992 Dolphin Electric Bike for the public. Today, pedal-assist is the norm for electric bicycles, while some companies have bikes that offer both pedal and throttle-style assistance. Additionally, more modern electric bikes now include Lithium-Ion batteries that provide more capacity with a lower weight compared to prior models [4]. The adoption of electric bicycles is on the rise globally, attracting both experienced and new riders. With the aid of an electric motor, biking has become more accessible to riders of all kinds; even mountain biking is now more popular due to the addition of e-bikes and fat tire bikes. An e-bike makes it possible to take commutes that would otherwise be too far, too long, or too slow. Many modern e-bikes are tailored to city riding and commuting. These bikes offer the benefits of comfort and efficiency, as well as the necessary componentry and infrastructure to get from one place to another, making them a popular choice for daily city riding [5].

Research by Adithya Kumar et al. (2018) has suggested that the waning of fossil fuels has increased the necessity of utilizing electricity in the future. Electric bicycles have been seen as an ideal solution for those who ride short distances or are office workers. This bike is powered by a range of sources which primarily consists of batteries. When the battery is drained, it is recharged by battery chargers. For this experiment, a DC motor/generator was connected to the rear wheel. This system functions with two sets of batteries, A and B. If one of the batteries runs out, the remaining battery steps in. During this time, the wheel rotates which generates voltage that helps recharge the battery, thereby improving the bike's range. It is silent, eco-friendly and pollution-free as it does not generate any emissions. If there is an emergency or bad weather, it can be recharged with an AC converter. This bike is suitable for young and old, and it can meet the needs of those who are economically challenged. The most important benefit of this bike is that it does not consume costly fossil fuels, and thus, is economical**.** The impacts of climate change are becoming increasingly evident, with rising temperatures, melting glaciers, and increases in extreme weather events. It is no longer a distant concept, but an ever-present reality that has caused significant disruption to societies and ecosystems. Evidence of the effects of global warming is everywhere, from the melting ice caps to the devastating floods in various parts of the world. As temperatures continue to rise, the repercussions will be severe and far-reaching [6]. According to Annette Muetze et al. (2008), there should be a more profound focus on the deregulation of electric bicycles. Establishing a general standard/guideline to be followed by electric bicycle designers/manufacturers could promote their increasing usage while also ensuring that the product's quality is not compromised. Custom-made bicycles, which are the most effective for a particular cycle, e.g. distance, city or hill, and "speedy bicycles" may help to balance out the additional weight and cost of bigger components. Further research into battery and drive technologies, as well as their implementation in electric bicycles, would be beneficial to the electric bicycle industry in this regard. Even though electric bicycles have become more technically advanced and continue to improve, further effort is needed to make them competitive with other vehicles [7]. Carlos Tovar (2009) presents a novel concept that cities are facing a daily accumulation of excessive traffic and noise. These issues, which are damaging air quality and health, are often caused by transportation. There is an innovative vehicle that is a good option for those looking for a speedy and efficient way of getting around while still being environmentally conscious. This vehicle is an e-bike, which costs the same as a regular bicycle and offers the rider all the features of a regular bike with the added power of a battery, allowing the user to go faster and further. This type of vehicle is considered to be the same as a standard bicycle by the law, and therefore doesn't require a licence to ride [8]. More et al. (2011) suggested that various models of calorie measurement need to be studied and tested in order to determine which one is the most suitable for a range of bikes. Additionally, researchers could investigate the possibility of creating a single model that would reduce the amount of calibrations necessary for a single cycle. To incentivize riders to switch from manual to electric mode when their calorie burning goals are met, incentive-based methods could be tested. Furthermore, a more stable battery supply is necessary for the anti-theft system to work. The features will be incorporated into the existing power supply of the bicycle. To ensure the product is resistant to harsh environmental elements, it must be cushioned, waterproof, and temperature insensitive within a particular range. This project aims to make the bicycle a more user-friendly and cost-effective form of transportation. Furthermore, efforts will be made to replicate a similar design for simpler bikes [9].

It can be concluded from the literature review that switching to an electric bicycle can not only save us a lot of money and reduce global warming in the long run, but also help us stay in shape. Electric Motor Bicycles have become increasingly popular in India, as they cause less pollution, require less maintenance, and are quieter than other vehicles.

Objective of the Present Work

- To create an efficient E-cycle that can be used on many types of roadways.
- To adapt the E-cycle to various requirements.
- To design an E-cycle using 3Rs (Reduce, Reuse, and Recycle).
- ➢ Reduce: Electric cycle can reduce the emissions.
- ➢ Reuse: The cycle can be reused from old condition.
- ➢ Recycle: The cycle has been recycled from scrap condition.

II. MATERIALS AND METHODS

1. DC HUB MOTOR (BLDC)

This system makes use of a brushless DC (BLDC) motor shown in figure 2, which is a type of synchronous motor with permanent magnets. In this motor, the stator and rotor generate magnetic fields with the same frequency, thus making it a long lasting motor. This motor has a high starting torque, fast no-load speed, and low energy losses making it a popular choice in e-bikes. Out of the various designs, three phase motors are the most common and commonly used in e-bikes. The system is chosen with a hub motor as it eliminates the need for chains or belts, making the e-bike smaller and lighter.

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Fig. 2 BLDC Motor

Fig. 3 Controller

Specifications of BLDC Motor

BLDC HUB MOTOR RARE WHEEL 36 V, 250 W

- Voltage:36 V
- Maximum current:10 A
- Maximum efficiency:85 %
- Torque:45 Nm
- Nominal power:250 W
- Peak power:350 W
- Maximum speed:30 Km/h

2. CONTROLLER

The electric bike controller shown in figure 3, is an essential part of an e-bike, as it is responsible for regulating the motor's speed, start, and stop. It is interconnected with the battery, motor, throttle, display, PAS, and other speed detectors. The controller is constructed with main chips and associated parts, including resistors, sensors, MOSFET, etc. Inside the controller, there are components such as a PWM generating circuit, an AD circuit, a power circuit, a power device driver circuit, a signal acquisition and processing circuit, an over-current and under voltage protection circuit, and a signal acquisition and processing circuit.

Specifications of Controller

- Compatible Motor: Hub Motor
- Body Material: Aluminium
- Cable Length(cm): 15
- Current Limit(A): 15
- Rated Voltage(V): 31 to 36
- Rated Power(W): 350
- Weight(gm): 211
- Length(mm): 90
- Width(mm): 50
- Height(mm): 30

3. BATTERY

Li-ion batteries shown in figure 4, are considered to be one of the highest energy density battery technologies available in the market today, with power levels ranging from 100-265 Wh/kg to 250-670 Wh/L. Furthermore, these batteries can also provide 3.6 volts of power, which is three times more than Ni-Cd or Ni-MH batteries. Additionally, Li-ion batteries do not require regular cycling to maintain their life and they do not suffer from the memory effect, unlike Ni-Cd and Ni-MH batteries. Moreover, these batteries have a low self discharge rate of 1.5-2 percent per month and lack hazardous cadmium, making them easy to dispose of.

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Fig. 4 Battery

Fig. 5 Display

4. Instrument Cluster

The cluster shown in figure 5, is being used to demonstrate the charging rate of the battery and the speed of the bike. This instrument cluster is a vital part of any vehicle since it is the visible display of the present state. It can also alert of electrical component malfunctions (EFI/ISG related) in addition to giving basic information on the vehicle. Clusters can be connected to the vehicle with plain technologies like encoders or with more intricate interfaces such as CAN, SAEJ1850, and so on.

Fig. 6 Throttle

Fig. 7 Light

Fig. 8 Horn

5. Throttle

Similar to the acceleration of a motorbike or scooter, you can power a bike forward without pedalling by pressing the throttle. Electric bikes have a range of throttle choices, from thumb to full twist. The rider can also regulate the amount of power produced through most of these throttles shown in figure 6.

6. Light

The LED lights shown in figure 7, being offered are very easy to use, and provide energy-efficiency. They are installed in electric bikes, and provide a luminous shimmer in the darkness of night. Their unique lens design makes it so that the light cup allows for the passage of light before it reflects as a whole. This produces a more efficient light beam, and reduces the loss of energy.

7. Horn

A horn shown in figure 8, is a wind instrument that is composed of a tube, usually metal, curved in a conical shape. The one end is tiny, where the musician blows and the other end is larger, from which sound is heard. In jazz and popular music, the term "horn" is used to refer to all wind instruments, and a horn section can be composed of brass and/or woodwind instruments.

Design of Electric Motor Bicycle

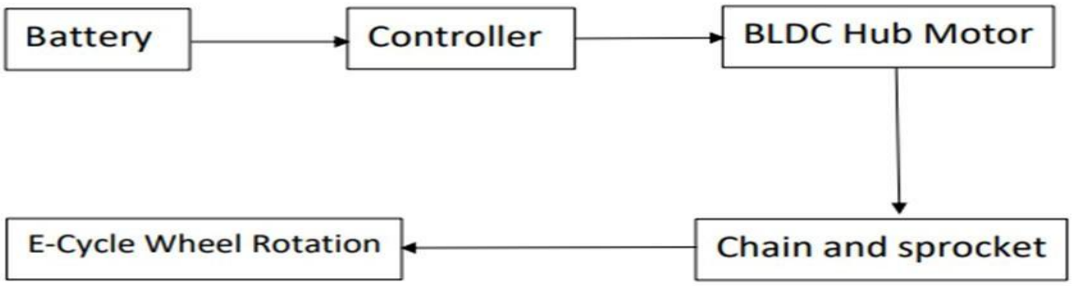

Fig.9 Block diagram of Electric Bicycle

The battery's current is transferred to the controller, where all the connections are established. Once the motor is powered up, the wheel is rotated by means of a chain and sprocket. The block diagram of Electric Bicycle is shown in figure 9

How to turn on our Electric Motor Bicycle

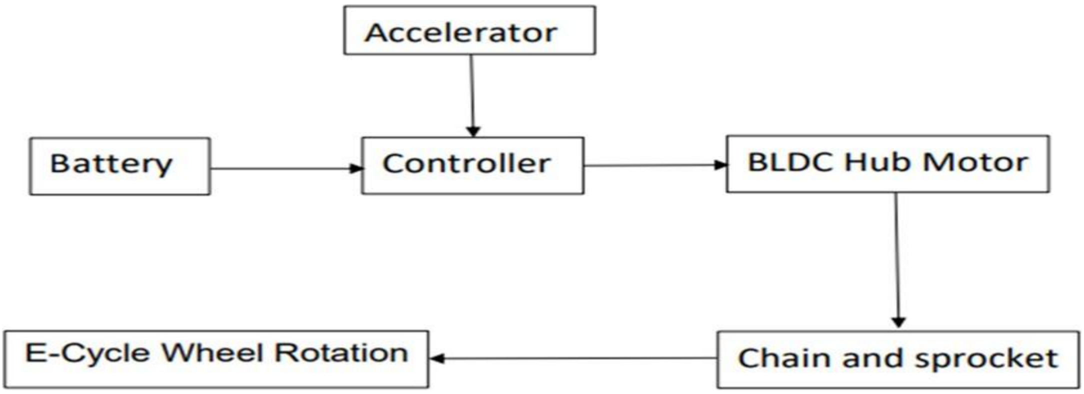

Fig.10 Block diagram of converting Electric Bicycle

To start the ignition, the key must be inserted. Push down and hold the power button found on the dashboard to activate the power supply. Once we turn the accelerator to the desired level, the controller will accept the input and send the allocated power to the motor, making it run in accordance. The block diagram of converting electric bicycle is shown in figure 10.

Working of Auto-Cut Off Brakes

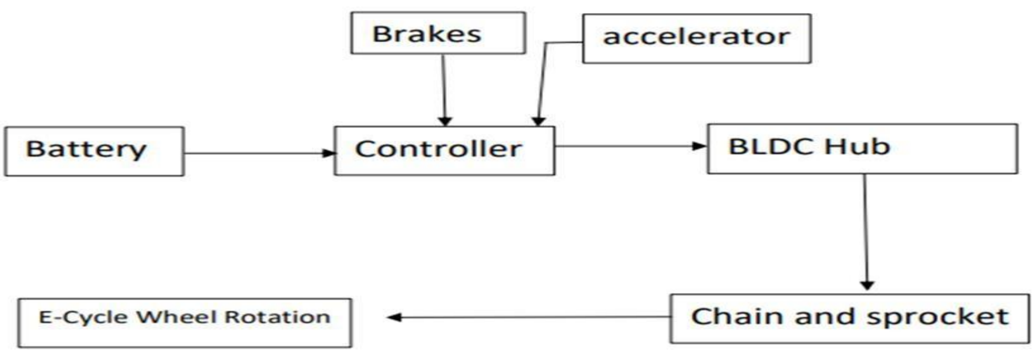

Fig.11 Block diagram for auto cut off brakes

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When the brakes are applied during either running or idle states, the controller will cut off the motor's power until the brakes are engaged. After the E-cycle continues at a constant speed for five seconds, it will switch to cruise mode and stay at the same speed. To revert back to regular mode, a slight press of the brakes or acceleration should do the trick. The Block diagram for auto cut off brakes in figure 11.

Working of Light and Horn

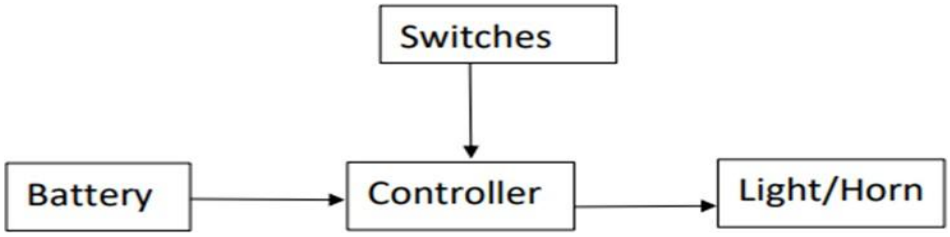

Fig.12 Block diagram for lights and horn

The handlebar has two switches, one for the light and the other for the horn. When the switches are pressed, the controller recognizes them and sends the proper signal for the light or horn. The Block diagram for lights and horn is shown in figure 12.

III. RESULTS

Once the transformation of the E-cycle was finished, we drove it on the street with various circumstances. It had a velocity of about 30 kmph and a range of more than 35 km, depending upon the driving environment. The time taken to charge it completely (0-100%) was about 4 hours. During the test ride, the transformation of a regular scrap cycle into a well-maintained e-Bicycle was clearly evident. The motor and lithium-ion battery performed efficiently, allowing us to cruise for up to 30 km (or more, depending on the driving conditions) at a speed of 25 km/hr with a fully charged battery. Recharging the battery took four hours. In addition, this e-Bicycle is cost-effective and eco-friendly, following the 3 Rs of the ecosystem.

IV. CONCLUSION AND FUTURE SCOPE

For the future, this cycle could be redesigned to include some new features. These could include a roof-top solar panel for recharging, a bi-directional controller which would generate battery power through pedalling, as this current project only has a single-direction converter, and the potential to convert other vehicles such as handicapped tricycles or cycle rickshaws.

REFERENCES

[1] https://www.radpowerbikes.com/blogs/the-scenic-route/the-history-of-ebikes
[2] Dill J and Rose G, 2012, Electric Bike and Transportation Policy.
[3] Fink S.D, Gulab L, Keshav S and De Meer H, 2017, How Similar the usage of Electric Cars and Electric Bicycles.
[4] Fluchter K and Wortmann F, 2014, Implementing the Connected E-Bike Challenges and Requirements of an IOT Application for Urban Transportation.
[5] Gebhard L, Golab L, Keshav S and De Meer H, 2016, Range Prediction for Electric Bicycle.
[6] Adithya Kumar, Srirenga Venkatesh, Satheesh Kumar, Pragatheeshwarar "Fabrication of Self-Charging Electric Bike" International Journal Of Pure And Applied Mathematics Volume 118 No. 22 2018
[7] Annette Muetze & Ying C. Tan 2007-2008, The Basic Configuration of an Electric Bicycle System.
[8] Carlos Tovar, "Electric Bicycle Design", Industrial Design, Jonkoping University, 2008-09.
[9] Ravina More, 2010-2011, To Design E-Bicycle with an Integrated Electric Motor which can be used for Propulsion.