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Design of Electric Bicycle

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Abstract : Modern world demands the high technology which can solve the current and future problems. Fossil fuel shortage is the main problem now-a-days. Considering current rate of usage of fossil fuels will let its life up to next five decades only. Undesirable climate change is the red indication for not to use more fossil fuel any more. Best alternative for the automobile fuels to provide the mobility & transportation to peoples is sustainable electrical bike. Future e-bike is the best technical application as a visionary solution for the better world and upcoming generation. E-bike comprises the features like high mobility efficiency, compact, electrically powered, comfortable riding experience, light weight vehicle. E-bike is the most versatile future vehicle considering its advantages.An electric bicycle is a tool that is produced from a combination of a bicycle as a means of transportation which is added with an electric component as its driving force. It is known that bicycles can still be used even without electrical components. However, with the presence of an electrical component, the human power that is expended can be minimized. The current environment has undergone various changes. This is intended because of changes that occur because of humans. By using a qualitative descriptive method, this study is expected to provide knowledge about the impact on the environment from using an electric bicycle. And the result is that currently, the diversity of electric bicycles does not only provide the development of the bicycle itself.

I. INTRODUCTION

The electric bicycle is an electrical-assisted device that is designed to deliver the electromagnetic momentums to a present bicycle therefore relieving the user of producing the energy essential to run the bicycle. It contains a strong motor and enough battery power that just needs charging to help in hill climbing, generate greater motoring speeds and provide completely free electric transportation. Electric vehicles price more and perform poorer than their gasoline counterparts. The aim is that mainly because gasoline cars have promoted from a century of intensive development; electric cars have been virtually overlooked for several years.

The single biggest advantage of electric bicycle is that it is cost operative as it mainly only entails building cost as running cost would only require the charging of the battery. An Electric bicycle would, however offer other solid benefits that are overlooked by the marketplace. These include the intense reduction in oil consumption that its widespread use would bring about. Much less oil would be needed because only a tiny proportion of electricity is generated from oil. The further major non-market benefit would be lower greenhouse gas emissions.

The market for electric motor powered bicycles has been growing fast during the last years. Such electric bicycles can be used for a large variety of purposes, including serving as a vehicle for police or law enforcers, a guide bike during races, and for leisurely rides and commuting. Common issues such as high cost and weight can be addressed by custom-designed bicycles for given contexts. Drives for electric bicycles are required to produce a variety of different pairs of torque and speed, and of rate of change of torque at a given speed.

II. NECESSITY

- High energy efficiency and portable design.
- Electric bicycle in case of use and maintenance.
- Low upfront cost.

III. OBJECTIVE

The main purpose of this research is to review the current situation and effectiveness of electric bicycle researched by various researchers. In order to approach this purpose, following objectives are specified:

- To maximize the speed and efficiency.
- To optimize the cost.

- To verify the proposed outcome by comparing it with practical result.
- Design of electric bicycle.

IV. SCOPE

- The scope of this project is to cost effective solution for Electric Bicycle
- Easy control and reliable operations
- The functionality of developed Electric bicycle can be further enhanced by implementing DC-DC converter which can give value addition in terms of regenerative breaking.

V. LITERATURE SURVEY

1] The Pedaled bicycles have low power electric motors, usually 250W, installed at the middle of the bike frame and connected to the bike chain. Although the electric motor transmits power towards the back wheel with the help of the chain, this type tends to have a higher efficiency, over 80%. This is true because in this case the electric motor runs at lower speeds and it is only assisting the rider, which means that he must turn the pedals in order the electric motor to help and that is why those bicycles are usually ridden up to speeds of 30-35 km/h. The lower the electric motor speed the lower is the generated back electromagnetic force. The low riding speeds contribute considerably to higher efficiencies for all EBs, because the lower the wind resistance, the lower the energy consumption for certain runs.

The Power-on-Demand EBs are also called Throttle EBs, because they are being controlled with the help of throttle, the same way as motorcycles. They are more fun, because the rider is not forced to help with its own force and they have the full electric power of the motor available on demand. In this case the electric motor usually does the work on its own, although the rider could help, if he desires.

2] Bike-sharing systems need to track and manage the renting of the vehicles; each bicycle is equipped with additional electronics that considerably change the electric power absorption profiles with respect to private use. In particular, the absorption while the bicycle is not being used cannot be neglected.

This section proposes a model of the human–bicycle system. The focus of the model is on the power fluxes. We organize the discussion in several components: vehicle dynamics, power train dynamics, trip dynamics, and cyclist dynamics.The typical use of a vehicle in a bike-sharing context is very different from the use of a private bicycle: by definition, a shared bicycle is used by a number of different users; the average trip is considerably shorter than in private use and the mission profiles have a larger variability than in private use.

3] For the comparative e-bicycle analysis, we had to take into account the e-bicycle that are currently on the market which have both pedal and throttle capabilities, i.e. the features are similar to the working of our e-bike torque sensor as such, we managed to find three bikes from which to collect information from the Akij Eagle, the Avon E-lite and the DP Durbar Electric Bicycle. The bikes were judged on five parameters: size, weight, distance, speed, and time to charge. The table below indicates that the e-bike would be much more costeffective than the current bikes on the market, and is not only lighter but also has a higher distance travel per price. It also sits in the speed department comparably and it also takes a reasonable amount of time to charge. Having set out with the goal of creating a cost-effective alternative to Bangladesh's current modes of transport, these counts as a major step towards that goal.

VI. SYSTEM DEVELOPMENT

Properties of bicycles in an average bike-sharing scheme are already a good approach to what a comfortable e-bike should look like. They are city-bikes with a step-thru frame, a rear rack for panniers or a basket mounted to the handlebars. With regards to cobblestone streets in Prague it is desirable to have some form of suspension. E-bikes with the same purpose should have a similar design except the design also involves a decision about where to place a motor and battery. The requirement of a minimal human effort includes optimal handling and steering behavior of the bike. The centre of a mass of the rider-bike system affects this behavior. In fact, the act of cycling is known to be a fairly complex mechanism.

In addition to the rider’s skill and gyroscopic forces, there are, acting on the wheel, the centre of gravity lowering torque and capturing forces. In the context of this project we can simplify it by saying that keeping a bicycle from falling comes down to keeping the centre of mass of the rider-bike system over its wheels. At very low speeds or when coming to a halt, the bike is easier to handle with a low centre of mass because thanks to the the leverage, the rider also needs to apply relatively small forces on the handlebars to keep the bike upright.

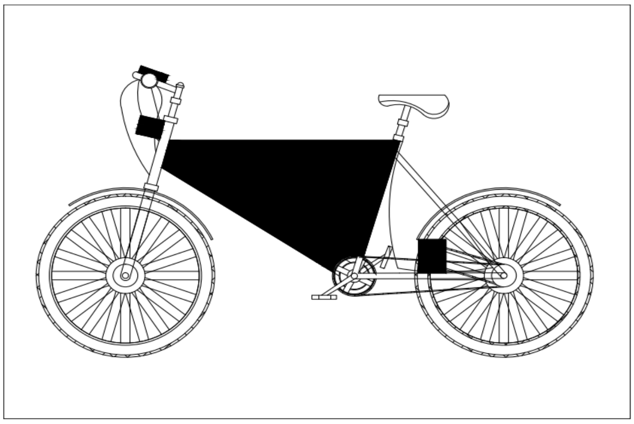

Fig.1.CAD Design

VII. Hardware Implementation

- Checking all the components are in working condition.
- Attach one additional bearing to opposite main bearing of back wheel of the bicycle.
- Attach PMDC motor to parallel to back wheel of the bicycle.
- Battery level inductor and speedometer are installed to handlebar.
- On the right hand of the handlebar the throttle is installing.
- Connection of all equipment like battery, controller and wiring and other group of components placed in center of the bicycle.

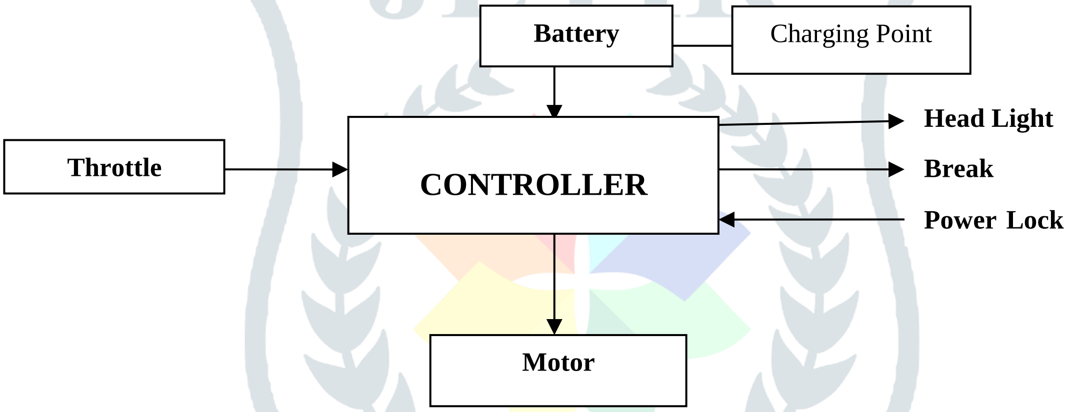

Fig.2. Block Diagram

VIII. Description of hardware model

1. Lead Acid 12V

A lead acid battery, also known as a lead storage battery is the oldest kind of rechargeable battery. The battery is common as an energy storing device. The lead acid battery was invented in the year 1859 by Gaston Planet, who was a French physicist. There are still many applications that make use of lead-acid batteries. These find wide usage in vehicles where the battery can provide high current for winding power .One of the singular advantages of lead acid batteries is that they are the most commonly used form of battery for most rechargeable battery applications for example, in starting car engines.

Fig.3.Lead Acid

2. PMDC Motor 250 Watt

The permanent magnet dc motor can be defined as a motor which includes a permanent magnet pole is called Permanent Magnet DC Motor. In this motor, the magnet can be used to make the flux working within the air gap in its place of the field winding. The rotor structure is similar to the straight DC Motor. PMDC Motor's rotor includes armature core, commentator, & armature winding. Normally, in a conventional DC motor, there are two kinds of winding such as armature as well as Filed. The main function of field winding is to produce the functioning magnetic flux within the air gap as well as wound on **the stator** of the motor while armature winding can be wound on the rotor.

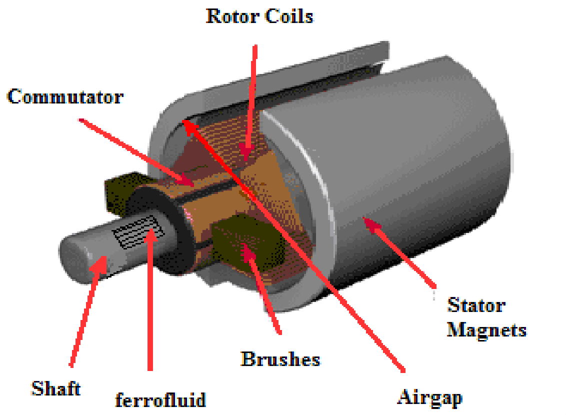

Fig.4. PMDC motor Structure

3. Throttle

It features linear control over E-bicycle motor and lets you change the speed of the vehicle according to your requirement. It obtains a direct connection with the E-Bike Controller Circuitry through the wire attached to it.

Fig.5. Throttle

4. Brake Lever

The e- bicycle brake lever is a replacement for the regular brake lever and either cuts out the controller or engages regenerative braking in the controller when the lever is squeezed. We have integrated levers for both mechanical and hydraulic brakes, as well as it can be added to your existing levers to turn them into e-brakes.

Fig.6. Brake Lever

5. **Speedometer Sensor**

By using circumference of wheel Sensor finds the speed. It is shows parameter in display:

- Current speed
- Maximum Speed
- Total Time
- Total Distance
- Current Time

Fig.7. Speedometer

IX. Flow of Hardware Model

- Electric bicycle works switching on input supply.
- Battery is an energy storing source which supplies energy to the all component.
- Each component of bicycle is connected to the controller.
- Basically throttle is use to control speed of the bicycle.
- According to increase speed of bicycle controller get that level of energy from the battery and provide to the motor.
- Also when breaks are applies regenerative breaking are happening.
- Speedometer shows the real time speed of the bicycle.

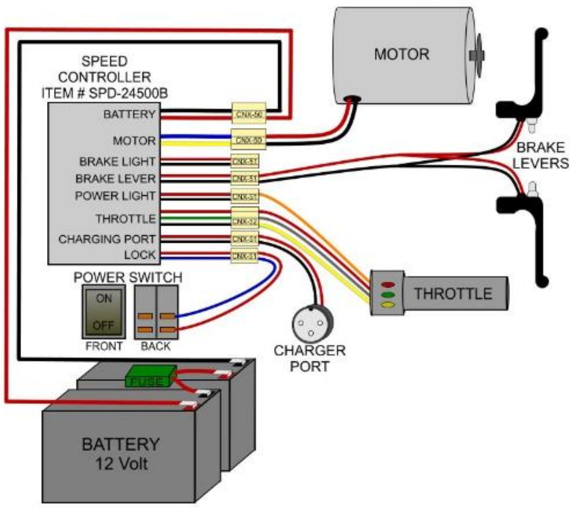

Fig.8.Circuit Diagram

X. PERFORMANCE ANALYSIS

Firstly, the balancing of the electric bicycle was found very easy. One indicator for this is that it was very easy to balance the bike without hands on the handlebar. The bike enabled flexible maneuvering. This proves the chosen placement of battery and motor to be correct.

Secondly acceleration, top speed in the throttle mode was up to 35 km/h on a flat in an upright position. The accelerations perceived a big difference with normal cycling. The ease of getting up to speed was so easy both with the pedal assistance and the throttle mode is similar to riding a scooter or a small motorcycle.

Another inconvenience is that not being able to go to a lower gear at low speeds or standstill feels rather unhandy regarding smooth accelerations. This is not any different with normal bikes but with this e-bike there was a tendency to prevent shifting too much and staying in a high gear for higher speeds. Because the brakes cut off the motor power there is no need to go down in gears when slowing down and coming to a stop.

Parameter	According to
Travel range(Full Charge)	25km to 35km
Battery Charging time	3 hours
Cycle of Charge	Up to 400
Power consumption	300 w h
Torque	6%(of Slope)
Weight of electric bicycle	15kg
Price	Rs 14000

Table.1. Specification

Fig.9.Hardware Result

1] Speed Calculation

STEP 1 :-

Number of teeth on smaller sprocket (motor) (t_1) = 9
Number of teeth on larger sprocket (bicycle) (t_2) = 18
Speed on smaller sprocket (motor) (N_1) = 3300 rpm
By using reduction ratio (9.78), speed will be reduced to 338 rpm
Speed on larger sprocket (bicycle) (N_2) = ?

STEP 2 :-

Using speed ratio formulae,

$N_1 t_1 = N$

$N_2 = 169$ rpm

Step 3:-

Diameter of wheel=650mm Circumference of wheel
=3.14*650
=2041mm

Step 4:-

Speed of vehicle = speed of wheel X circumference of wheel
=169 X 2041
=344418075 mm/min
=344.41 m/min
=20665 m/hr
=20.66 Km/hr

2] Required Power to Drive Bicycle

Step (1):-

Total load act on bicycle is as follow Normal weight of person =65 kg
=65*9.81
=637.65N

Weight of bicycle= 5 kg

= 5*9.81

= 49.N

N Other Miscellaneous load =5 Kg =5*9.81

= 49.05 N

The total load = (637.65+49+49.04)

= 735.65N

STEP (2):-

To find reaction on each wheel, The above total load which is divided equally on both wheel

Force (F_{fw}) =Force(F_{rw})

=735./2

=367.8N

Where reaction on rear and front wheel are as follows

R_{fw}=R_{rw}

=0.2*340.5

=73.56 N

STEP (3):-

To find torque on each wheel Total torque=T_{fw}+T_{rw}

To find Torque on Front Wheel T1 = R_{fw}*(D÷2)

$=68.1*[(65*10^{-2})/2]$

=22.1325Nm

T1=T2=22.1325Nm

Total torque on wheel=44.265 Nm

STEP(4):-

To find power on motor = 391.69 watt

Voltage (v)	Speed (rpm)
3.7	70
7.4	125
11.1	175
14.8	225
18.5	280
22.2	338

Table.2.Voltage & Speed (RPM)

Weight (Kg)	Speed (Km/ph)
35	30
40	28.5
45	26
50	25
55	23.75
60	22
65	20.50
70	18.75

Table.3.According to weight Bicycle Speed

XI. CONLUSION

The objective of a comfortable, compact, high speed and efficient bicycle can be achieved by this various experiment results obtained by different authors by advancement in current Electric bicycle model. This advancement includes the pre-discovered results from literatures like the selection of materials of frame tubes, aerodynamic design.

In a growing developing country such as India, the electric bicycle will one day revolutionize the way people travel, and provide people with a better, more environmentally sustainable alternative. Introducing the torque sensor technology, it reaffirms the minimization of the energy consumption from batteries by the load.

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