Multi-Powered Hybrid Two-wheeler

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Abstract— Keeping in mind the drawbacks of electric and conventional IC engine bike, this project was brought up to find a solution between them. Our hybrid two-wheeler will contain electric motor which will help in reducing the pollution produced by the burning of fuel in IC engine and to increase the efficiency which will lead us to less fuel wastage, whereas the IC engine will help us to increase the range of the electric drive in the two-wheeler by charging its battery when the vehicle will be running on IC engine. Also, it will help us to increase the power compared to the electric drive vehicle. By selecting hybrid vehicle, advantages can be achieved over conventional and electric drive vehicle. Also, the two-wheeler will still remain the same in terms of riding comfort and could easily be repaired. Also, no major modifications are required.

Keywords—Multi-powered Bicycle, Hub motor, Hybrid Vehicle, Battery, Electric bicycle, Gasoline Engine bicycle, Bicycle, Customized bicycle.

I. INTRODUCTION

A. Hybrid vehicle

According to dictionary definition for hybrid is “an offspring of two animals or plants of different races, breeds, varieties, species, or genera.”

The vehicle that combines more than two sources of power is said to be hybrid vehicle.

B. Concept

A hybrid vehicle combines an electric vehicle with IC engine as alternative source of energy as a power unit.

A hybrid can obtain the high-range and performance benefits of conventional vehicles with the less noise and exhaust emissions, and energy independence benefits of electric vehicles.

Accordingly, the hybrid concept, where the alternative power unit is used as a second source of energy, is gaining acceptance and is overcoming some of the problems of pure electric vehicles.

C. Problem Definition

<table>
<thead>
<tr>
<th>Table I</th>
<th>Comparison of both the technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Two-wheeler</td>
<td>Conventional Two-wheeler</td>
</tr>
<tr>
<td>It yields less power comparing to the conventional engine</td>
<td>The engine produces pollution which is undesired</td>
</tr>
<tr>
<td>Load carrying capacity is less</td>
<td>Frequent maintenance is required to keep it running in smooth condition</td>
</tr>
<tr>
<td>It has less driving range</td>
<td>It has less driving range</td>
</tr>
<tr>
<td>It less economical</td>
<td></td>
</tr>
</tbody>
</table>

D. Solution methodology

Hybrid vehicles posses benefits of both: gasoline engines and electric motors. They can be targeted to meet various goals: fuel economy or increased power.

A HEV is much cleaner and needs less fuel to run which shows less emissions and less reliance on fossil fuels. This in return also helps to reduce the price of petrol in domestic market.

A HEV is eligible to produce instant torque due to the presence of electric motor in its drive train.

II. COMPONENTS AND ITS SPECIFICATION

A. Frame

A bicycle frame is important component which support various other parts mounted on the bicycle likewise, it has to be strong enough to withstand various stresses acting on it either it is bending or torsional.
The diamond frame holds of triangles which is a main triangle and a paired with rear triangle. The main triangle holds of the head tube, top tube, down tube and seat tube.

![Figure 1: Diamond Frame](image)

**B. Hub Motor**

The hub motor is an electric motor which is directly mounted onto the wheel hub and drives the wheel directly and is operated by electric power.

This hub motors has stator connected to the case within a planetary gear system. For each rotation the motor inside hub actually turns much faster. This helps the motor to work at higher and more efficient speed and allowing the wheel to rotate at a slower driving speed.

<table>
<thead>
<tr>
<th>Core Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Rear Motor</td>
</tr>
<tr>
<td>Wheel Diameter (Inch)</td>
<td>26/27.5/28</td>
</tr>
<tr>
<td>Construction</td>
<td>Gear Drive</td>
</tr>
<tr>
<td>Rated Voltage (DCV)</td>
<td>36/43</td>
</tr>
<tr>
<td>n0 (Rpm)</td>
<td>295 ; 250</td>
</tr>
<tr>
<td>Rated Power (W)</td>
<td>250</td>
</tr>
<tr>
<td>nT(Rpm)</td>
<td>260 ; 220</td>
</tr>
<tr>
<td>Max Torque</td>
<td>32 N.m</td>
</tr>
<tr>
<td>Efficiency (%)</td>
<td>≥ 80</td>
</tr>
<tr>
<td>Color</td>
<td>Black / Silver</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>2.8</td>
</tr>
<tr>
<td>Noise Grade (dB)</td>
<td>&lt; 55</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-20-45°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mounting Parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake</td>
<td>Disc Brake</td>
</tr>
<tr>
<td>Installation Widths (mm / OLD)</td>
<td>135</td>
</tr>
<tr>
<td>Max. Housing Diameter (mm)</td>
<td>136</td>
</tr>
<tr>
<td>Cabling Route</td>
<td>Through Shaft, Right</td>
</tr>
<tr>
<td>Cable Length (mm), Connection Type</td>
<td>250 G6.1</td>
</tr>
<tr>
<td>Gearshift</td>
<td>Freewheel (6S/7S/8S/9S)</td>
</tr>
<tr>
<td>Spoke Specification</td>
<td>36H * 13G</td>
</tr>
</tbody>
</table>

![Figure 2: Hub Motor Specification](image)
C. Controller

A motor controller is a device that controls the speed and performance of an electric motor. A controller operates manually and automatically means to start and stop the motor by selecting forward or backward rotation and controlling the speed or limiting the torque, and providing protection over against overloads and minor faults. It has a small lever that proceeds from the handlebar towards the rider.

<table>
<thead>
<tr>
<th>Rated Voltage</th>
<th>12 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated for Motors</td>
<td>Up To 250 Watts</td>
</tr>
<tr>
<td>Maximum Current</td>
<td>25 Amps</td>
</tr>
<tr>
<td>Rated for Chargers</td>
<td>Up To 3 Amps</td>
</tr>
<tr>
<td>Conversion Efficiency</td>
<td>95%</td>
</tr>
<tr>
<td>Under Voltage Protection</td>
<td>10.5 Volts ± 0.5 Volt</td>
</tr>
<tr>
<td>Recommended Fuse or Breaker Size</td>
<td>30 Amps</td>
</tr>
<tr>
<td>Dimensions</td>
<td>3’’ Long x 2-3/8’’ Wide x 1-1/12’’ High</td>
</tr>
</tbody>
</table>

A lithium-ion battery is a very much light and high-powered battery. This battery will have an average of 600 charge cycles.

E. Engine Specification and components

Specifications:
- Material: heavy duty metal
- Engine Type: Single cylinder, Air-cooling, 2-stroke gasoline engine
- Fuel Tank Capacity: 2L
- Transmission Ratio: 18:1
- Compression Ratio: 6:1
- Lubrication Oil: 2stroke machine oil (or 10W/40, 10W/30 machine oil)
- Mixing Ratio of Fuel and Engine Oil: 16:1 for new sets, 20:1 after running 500KM
- Fuel Consumption: 4L/100km
- Fuel Type: 90#
- Clutch Type: Rub bloc drying
- Maximum Speed: 38km/h
- Maximum Power: 2.2kW/600r/min (5-6HP/6000r/min)
- CDI ignition, Sprocket Shifting
- Spark Plug: Z4C 14mm

III. IMPLEMENTATION

A. Hub Motor Mounting:

The main parts which are required to mount hub motor on the rim are 36 pieces of 12 gauge spokes, nipple and the hub motor. The nipple is supposed to be inserted into the eyelet, for that, its diameter should be slightly smaller than the eyelet so that it can be easily inserted. The diameter of rim is 511mm (26 inches) so the spokes should be of 155mm length. The diameter of both eyelet and nipple is 4.5mm which is smaller than required. For this reason the eyelets are needed to be drilled up to 4.8mm. After drilling, the first spoke should be inserted into the hub from left side, similarly the next spoke from the right side. The same procedure is to be repeated for all other spokes. After the spokes are firmly held on the rim through nipples, firstly one spoke is to be held from the left side then it should be crossed to fix another spoke on the left side. Second, two spokes are to be crossed on the right side and will be required to be fixed. On each side, i.e. left side and right side, a group of four spokes should be visible after the assembly is completed. A wrench can be used to tighten the spokes. This completes the mounting of the hub motor on the wheel.

B. Engine Installation

The engine is to mounted between the down tube and the seat tube of bicycle. Engine position is to be set so when the exhaust is installed it points towards the ground, parallel to the down tube. The exhaust needs to be detached to tighten the mounting nuts. So when positioning the engine, there is no need to tighten the exhaust silencer to the engine. Bicycle frame adapter installed to the engine the bike frame on that area.
C. Chain Sprocket Installation:

The Drive Chain Sprocket mounts on left side of the rear rim against the spokes dish side in. The sprocket must be mounted above the hub in a perpendicular with the axle which ensures that your rear chain sprocket spins along with the rear bike wheel. Applying thread adhesive and equally tightening of the sprocket bolts. This keeps the chain sprocket along with axle and free from wobble while spinning. The drive chain is to be shortened to achieve the correct length, for that specific tools are required to remove and replace the master link when shortening the chain by removing links. Ideally, both the chain (pedal drive chained and engine drive chain) should have same tension. By removing the left cover plate from engine which is the plate next to and beneath the clutch swing arm. The spark-plug wrench to turn engine crankshaft sprocket to feed chain around it. Reconnect the master link, and replace cover plate on engine. Chain tension adjustments can be made by moving rear wheel. Both chain have equal tension so installing the idler assembly is not necessary.

D. CD Ignition Coil and Engine Kill Switch installation

CD ignition coil should be mounted on bike frame that is close enough to connect coil wire to spark plug and appropriately far away from exhaust pipe to avoid heat damage to semiconductors in CDI module. CD ignition coil wires are connected to same identical color-coded wires coming from engine. After the previous stated steps install Engine Kill Switch on the handlebar or use kill switch on left hand grip.

E. Clutch Installation

To install clutch cable fix the clutch lever to left side of handlebar and join cable end to lever. Route clutch cable through the ball-mount on motor with the big spring around the cable, which will act as heat shield. Insert cable wire through small spring and fix it to the clutch arm; further, adjust cable tension to allow slight play in lever.

F. Carburetor and Throttle Installation

The tiny stop on the cable wire slides along the long groove of the carburetor cylinder slide made up of brass. It is held in a slot at the end of the cylinder. The spring is positioned in the inner side of the cylinder slide and is than compressed when the throttle is twisted. The spring as a result forces the throttle to return. For this to work appropriately the throttle must twist freely and swiftly on the handle bar in both directions prior to the cable being installed. Install twist grip throttle on right side of handlebar end. On some bike handle bars, it may be necessary to make some modifications on the handle ID to fit the bar so that the throttle will twist freely. After installing cable inside the carburetor, mount the carburetor on engine intake tube and tighten clamp screw.

G. Mounting of various parts on bicycle:
H. Circuit Diagram:

This above shows the circuit connection of the bicycle this precisely shows the connection of all the components are to be connected. First battery is connected to a power switch which controls the power supply. Then it is connected to the controller. Controller controls the voltage that is to be supplied to the motor by the input from the throttle movement. And there is an charging circuit connected to the battery.

IV. Calculation

A. Calculation for selection of hub motor as per required power

For selection of hub motor we have to calculate the power required to compensate the various opposing force acting on bicycle like drag force, friction force & gradient force. We have to choose motor that can produce power which can overcome all this force and can run without any problem if there is variation in such force. Various formulas that are used for calculating overall force acting on bicycle:

\[ P_{\text{total}} = P_{\text{drag}} + P_{\text{hill}} + P_{\text{friction}}, \]

\[ P_{\text{drag}} = C_d \cdot D \cdot A \cdot 2 \cdot (v_g + v_w) \cdot 2 \cdot v_g, \]

\[ P_{\text{hill}} = 9.81 \cdot G \cdot v_g \cdot m, \]

\[ P_{\text{friction}} = 9.81 \cdot m \cdot R_c \cdot v_g. \]

Now substituting this value in above equations we get the values of various forces:

\[ P_{\text{hill}}: 38.4w \]
\[ P_{\text{drag}}: 100.5w \]
\[ P_{\text{friction}}: 82.32w \]

\[ P_{\text{total}} = 38.4 + 100.5 + 82.32 = 221.22w \]

B. So by obtaining the value of overall force acting on vehicle we concluded that the 250watt hub motor will be sufficient for propelling the bicycle.

C. Calculation For Battery:

Formulas

\[ P = V \cdot I ; \]

\[ I = 6.9Amp \]

\[ B_{\text{ah}} = \text{Capacity (per cell)} \times \text{no. of cells} \]

\[ = 3.5 \times 10 \]
\[ =35 \text{AH} \quad \ldots \ldots \text{(6)} \]

Bah =I*T

\[ 35 =6.9*T \quad \{\text{from eq(7)} \& \text{(8)}\} \]

T=5.072 hours \quad \ldots \ldots \text{(9)}

Equation (9) is the the time that battery can run after full charge.

D. Stopping Distance

<table>
<thead>
<tr>
<th>Variables</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal distance of C.G. from rear</td>
<td>0.5735</td>
<td>L(m)</td>
</tr>
<tr>
<td>Wheel base of bicycle=1.11</td>
<td>1.11</td>
<td>B(m)</td>
</tr>
<tr>
<td>Height of C.G.=0.11</td>
<td>0.11</td>
<td>H(m)</td>
</tr>
<tr>
<td>Coefficient of friction</td>
<td>0.6</td>
<td>u</td>
</tr>
<tr>
<td>Gravitational acceleration=9.8</td>
<td>9.8</td>
<td>G(m/s^2)</td>
</tr>
<tr>
<td>Deceleration</td>
<td>?</td>
<td>F(m/s^2)</td>
</tr>
</tbody>
</table>

For rear wheel:

\[
\frac{F}{g} = \frac{u(b-l)}{b+uh} \\
F=2.6 \text{ m/s}^2 \\
\text{Stopping distance}=V^2/2f \\
\text{Stopping distance}=9.27m
\]

For front wheel:

\[
\frac{F}{g} = \frac{ub}{b-uh} \\
F=3.23 \text{ m/s}^2 \\
\text{Stopping distance}=V^2/2f \\
\text{Stopping distance}=7.26m
\]

For both wheel:

\[
F=ug \\
F=5.88 \text{ m/s}^2 \\
\text{Stopping distance}=V^2/2f \\
\text{Stopping distance}=4.1m
\]

V. PROPOSED WORK

A. Team Goals:

Our team has certain goals in mind while taking up this project and we think we will be able to accomplish once we fabricate the vehicle considering that we can obtain the best possible result.

B. Task we keep in mind and worked upon:

- Every single company/person aims at doing their work in best possible way but not at the cost of comfort. There is a direct relation between comfort and efficiency. If the employee/worker is not comfortable doing his work efficiency decrease and so that they can work at their level best by reducing the manual labour and thus reducing fatigue or increasing comfort.

- The people who are always left behind are the unhealthy people. And our team through various surveys had come to the conclusion that we need to help them so that even they feel that they are capable, which gives them mental strength and besides this our project will also help them to overcome their physical complications. For this purpose, we have kept the electrical and mechanical source of powers.

These were the social causes we kept in mind before taking up the project but then we also sensed the need of helping our beloved planet that is doing all this without harming the planet.

So instead of conventional bicycle we decided to go for the hybrid vehicle.

This hybrid bicycle will have negligible emissions. Hence resulting in reduced pollution and economical to use.

REFERENCES

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