Eco-friendly Tricycle Vehicle for Physically Handicapped Person

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Abstract - It is always a great challenge for the patients, disabled and aged people to move in to the places like bus stops, hospitals etc. hence options are limited as very few form automobile industries. So keeping in the mind the limitations of handicapped person and to reduce his efforts we designed and manufactured power operated tricycle vehicle for handicapped person by giving some other useful features. This tricycle is convenient to a handicapped person as well as affordable to a poor person, as cost is major issue for them.

Key Words: Tricycle, Eco friendly, Electric motor, physically handicapped, Retrofitted

1. INTRODUCTION

Technology is developing fast and every day new developments are being done. Most of the developments are done keeping in view, normal human beings. However very less thought is given for development of means for handicapped person. In order to taking the handicapped with mainstream of society idea of designing vehicle for such person is developed. A conventional mechanical tricycle make it hard to drive in poor road condition or on a gradient Where as modified scooter require regular maintenance and operating cost is comparatively high. Smart wheelchairs also an option but it is suitable for short distance and cost associated with such chair is too much high.

This project aims to mitigate the above listed problems by designing and fabricating a tricycle which will be driven by an electric motor with simplified electric drive system eliminating chain and sprocket mechanisms.

2. LITERATURE REVIEW

There are different type of vehicle developed for physically handicapped person like Hybrid Tricycle, Modified scooter which is driven by IC Engine, Solar operated tricycle, Smart wheelchair etc. Cost of Modified scooter is around 70000. Solar tricycle requires photovoltaic cell which are high in cost.

Ravikumar kandasamy- Ravikumar have developed solar operated tricycle for physically handicapped person and he made it especially for an NGO started by Baba Amate. Main components of tricycle was Solar panel (Photovoltaic cell) and frame to support panel, PMDC motor, Battery and charger controlling unit. Ravikumar developed a tricycle completely pollution free.

Ajit Mohekra- He designed a retrofitted tricycle by modifying the existing scooter. He also design special platform arrangement so a wheelchair occupant can easily hold or leave the tricycle. This trike can be use for a long distance making it suitable for long journey.

Jayaprakasra- She proposed an innovative design of battery powered vehicle. Vehicle equipped with three wheels at rear and one at front. Power is given to the rear middle wheel and remaining rear two wheels are for support ,accommodate the suspension. In spite of all this feature it was sophisticated design due to extra wheel.
3. DESIGN CALCULATION

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>392.4</td>
</tr>
<tr>
<td>Battery</td>
<td>147.15</td>
</tr>
<tr>
<td>Rider</td>
<td>686.68</td>
</tr>
<tr>
<td>Front wheel</td>
<td>34.33</td>
</tr>
<tr>
<td>Wheel with hub motor</td>
<td>88.48</td>
</tr>
<tr>
<td>Wheel without hub motor</td>
<td>55.05</td>
</tr>
<tr>
<td>Handle</td>
<td>44.28</td>
</tr>
<tr>
<td>Luggage box</td>
<td>107.91</td>
</tr>
<tr>
<td>Accessories</td>
<td>45.35</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>49.03</td>
</tr>
<tr>
<td>Total</td>
<td>1765.8 (180 kg)</td>
</tr>
</tbody>
</table>

3.2 Running Parameters

As vehicle is being design for disabled person speed is limited to 25kmph and any vehicle having speed below 25kmph requires no RTO registration. Radius of vehicle is 203 mm (8 inch) thus rotational speed of wheel is limited to 327 rpm.

Motor must overcome following resistances while driving.

1. Air Resistance (RA) = 7.06N

2. Gradient Resistance (RG) = GVW×Sinθ
   θ=1 to 7 degrees
   GVW=1765.8N
   RG = 1765.8×sin 5 = 153.89N

3. Rolling Resistance (RR) =μ ¯~GVW
   RR=0.06×1765.8
   RR= 105.94 N

4. Acceleration (Fa) =m×a
   Taking acceleration as 5 m/s²
   (Fa)=180×5= 900 N

3.3 Energy consumed by batteries

No of batteries used in the tricycle are four. Battery has the following specification:
- Type: Lead Acid
- Battery Rating: 20Ah
- Voltage:12V
- Total Voltage:12×4=48V
- Output current: 2.7A (0.5A variation)

Energy consumption in 1 hour=Ah rating×Voltage
=20×48
=960Wh or 0.960KWh

Charging time for single battery =Battery Ah rating /charging current
=20/2.7 =7.40 hrs.

Given Lead acid batteries take maximum 7hrs to full charging. Energy consumed during this hours is given by

=Unit hour consumption×No. of hours taken to charging
=0.960×7
=6.72 KWh

Tariff of MSEB =6 rupees/unit for residential meter connection. (Average tariff)

Now charges for given energy consumption
=unit rate×Energy consumption
=6×6.72
=40.32 rupees

In a single charge vehicle covers maximum distance of 45 km, Cost per km can be found easily
=40.32/45
=0.89 Rs/km

4. COMPONENT SELECTION

Tricycle consist of various components like motor and controller, chassis, batteries, Voltage converter and speed control and brakes.
4.1 Frame

Frame is the supporting member of the tricycle and subjected to static and dynamic load. It also takes various load like vertical load, Cornering load, side thrust, acceleration and brake dip. Various Accessories and components are mounted over the frame. A frame should have sufficient strength to stand against all the listed loads. Weight of the frame should be as minimum as possible to reduce the overall weight of tricycle. Cost of the material of frame must be low. We selected the frame by considering available sizes of pipe, maximum stresses developed in the critical component and available factor of safety. Selected hollow pipe has the following specifications.

- Material: AISI 1018
- Outer diameter: 25.4mm
- Inner Diameter: 21.4mm
- Thickness: 2mm
- Sut: 440 N/mm²

![Catia Model of Frame](image)

4.2 Batteries

To run the motor at full load condition for 2-3 hours it requires energy about thrice of capacity of motor, along with this batteries should provide high energy demand during starting without affecting the further performance. Battery power can be estimated by Voltage and current rating. Batteries must have high voltage in order to provide abundant energy supply and to maintain voltage drop as minimum as possible. Another requirement of batteries is low cost and low maintenance. Lead acid batteries fulfill the second condition. Voltage of system can be increase by connecting it in series. Considering above parameters lead acid battery is suits best.

Selected batteries have following specification

- Current rating: 20Ah
- Voltage: 12V
- No. of batteries: 04
- Combination of batteries: Series
- Combined Voltage: 48V

4.3 Motor

To drive the vehicle at a speed of 25kmph and provide a rated torque about 5 N-m a motor having capacity above 200 watt is sufficient. Next Standard available motor is in capacity of 250 watt. Thus we have taken a Brushless DC motor of hero optima electric bike. The motor available in wheel itself i.e. hub motor. Hub motor of this kind is available in authorized workshop of hero motors. Cost of hub motor is below 5000 making it suitable for low cost application. Vehicle having electric power source of more than 250 watt requires RTO registration. Selected motor give us exemption from RTO registration.

Selected motor give us exemption from RTO registration.

Specification of selected hub motor.

- Type: Brushless DC Motor
- Power: 250 Watt

4.4 Controller and Voltage Converter

Motor draw the current from batteries according the need of the driver. Controller takes different input like brake, acceleration and vary the power supply to the motor. We selected standard controller taken from the hero electric’s bike and installed it with the given hub motor of same bike model. It has the following specification

- Operating current: 19A
- Operating Voltage: 48V DC
- Phase angle: 120 degrees

Tricycle does have different accessories like horn, Headlight, Indicator lamp, Brake light and all of those operates on 12V. But combined voltage of system is 48V thus it is essential to convert 48V into 12V and DC-DC Voltage converter serves this purpose. Along with voltage conversion it also gives protection from over current, short circuit and low voltage. The converter used in given tricycle has the following specification.

- Red wire/Input: DC 31V-59V
- Yellow wire/Output: DC 12V
• Black wire: Cathode(Earth)

4.5 Battery Charger

Battery gets drains after running a distance of 60 km and it does requires to recharge it. For the sake of charging a charger is required. We cannot charge batteries direct from AC current supply. It requires to convert AC current into DC. Charger Convert AC to DC. It consist of step down transformer, rectifier and filtering circuit to supply constant voltage.

Specification of selected charger

- Input voltage: 170-300V
- Input current: 1A max
- Output voltage: DC 59V
- Output current: 2.7A

5. COST ESTIMATION

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost (RS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>3000</td>
</tr>
<tr>
<td>Hub Motor wheel</td>
<td>3320</td>
</tr>
<tr>
<td>Controller</td>
<td>8350</td>
</tr>
<tr>
<td>Battery set</td>
<td>1530</td>
</tr>
<tr>
<td>DC-DC Converter</td>
<td>700</td>
</tr>
<tr>
<td>Battery charger</td>
<td>460</td>
</tr>
<tr>
<td>Accessories</td>
<td>1250</td>
</tr>
<tr>
<td>Wheels</td>
<td>600</td>
</tr>
<tr>
<td>Fabrication</td>
<td>1700</td>
</tr>
<tr>
<td>Other</td>
<td>590</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21500</strong></td>
</tr>
</tbody>
</table>

6. RESULT AND DISCUSSION

1) The charging time required for the batteries for one run is 7 - 8 hrs.
2) The maximum distance covered by the vehicle in single charge is 40 -45 km.
3) The maximum speed of the vehicle is 30 kmph
4) Power can be given to both of the rear wheels and in case of failure of one motor secondary drive will be helpful.
5) Speed can be increase by using more capacities battery and motor which increases the transportation speed on the other hand it needs vehicle registration according to central motor vehicle rule.

7. CONCLUSIONS

1) The objective of the study was to design an eco-friendly vehicle which will be affordable to poor handicapped person.
2) We mitigated problems faced by previously designed model.
3) As compared to IC engine vehicle, running cost of tricycle is almost half.
4) Tricycle has been fabricated and tested successfully. Different parameters like running range, cost per kilometer, Discharge time of battery has been measured with actual running condition and it delivered better results.

REFERENCES


BIOGRAPHIES.

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