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Design and Fabrication of Electric Vehicle for Physically Challenged Person

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***Abstract:** This article studies on a design and fabrication of Electric Vehicle (EV) for physically challenged person. In current scenario, a physically challenged person has facing a problem of transportation during their travel from one place to another place without safety and convenience. They find it difficult to react to situation in front of them. In order to solve these problems, an Electric Vehicle (EV) is designed where they can travel easily and safely. The major components of EV consist of battery, electronic commutator with control unit, BLDC motor and mechanical structure. The main merits of developed EV has no pollution, no fuel cost, less weight, modified mechanical structure, high pulling capacity, comfortable spacing for person travel, easy maintenance, less number components in comparison with existing EV. The gross weight of designed vehicle with load (person) has 300 kg (approximately). The performance of the developed EV is validated at different running conditions for monitoring the battery back-up and time durations.*

***Keywords:** BLDC motor with controller, E-Vehicle, Mechanical Structure*.

I.INTRODUCTION

In recent days, the transportation is essential for travel the person from one place to another place with growing population in India. An Electric Vehicle (EV) is mostly used for intention of transportation in India and also, it is more suitable for physically challenged person. An EV uses one or more electric motor or traction motor for propulsion.

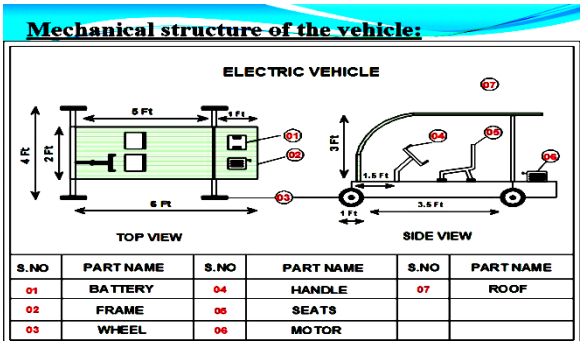
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An EV may be powered through a collector system by electricity from off-vehicle sources or may be self contained with battery electric generator or solar panel to convert fuel to electricity [1]. The main benefits of EV has cheaper cost to run, less maintenance, no fuel cost, less vehicle weight, Eco friendly, green power. In addition, the weakness of the EV has reduced range and more initial cost. Electric auto rickshaw for a sustainable transport system has been reported [2]. However, the main problem of design EV has more cost and complexity structure. Design of TRICYCLE for physically disabled person is well reported [3]. But, this EV can travel only one person with un-comfortable manner. Solar battery charging state and torque sensor based electrically assisted vehicle has been well presented [4]. Still, the developed model has less comfort and in-efficient model. So as to solve these problems, an EV is proposed where they can travel easily and safely. Experimental verification of eco-friendly vehicle for physically handicapped person has been reported [5]. Still, this design is complex in the model and costly. Development of e-vehicle for handicapped person and inverters/choppers are well reported [6-8]. Still, there is a problem in the structure of EV. In order to rectify these problems, a modified structure electric vehicle is designed. Therefore, in this article, it is attempted to design and fabrication of EV for physically changed person. The design of EV is detailed. It is tested at different operating conditions.

II.DESCRIPTION OF DESIGNED ELECTRIC VEHICLE

The fig.1 shows the proposed EV and its main components. The function of the each component of EV as follows;



S.NO	PART NAME	S.NO	PART NAME	S.NO	PART NAME
01	BATTERY	04	HANDLE	07	ROOF
02	FRAME	05	SEATS		
03	WHEEL	06	MOTOR		

Fig. 1 Proposed EV structure with their components and its dimensions

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Battery

It converts the chemical energy into the electrical energy. Also, it provides the power to the motor. Here, lead acid battery is employed to drive the Brushless DC motor (BLDC) motor (refer the Fig.2).



Fig. 2 Picture of lead acid battery model

BLDC Motor

Brushless DC motor (BLDC) motor use a rotating permanent magnet is soft magnet core in the rotor, stationary electrical magnets on the housing (see Fig.3). The main benefits of BLDC motor drive have long life span, little maintenance, good efficiency. But, the initial cost of this motor is high.

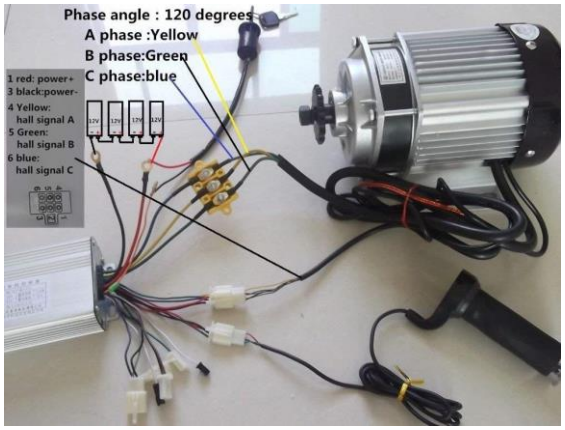


Fig. 3 Connection diagram of BLDC motor drive

Motor controller

It is a device or collection of devices (electronic commutator and control unit) that serves to govern in some prearranged manner of a electric motor performance. It includes a manual or automatic starting and stopping of the motor, choosing forward or reverse rotation, selecting and regulating the speed, and protecting against overloads and faults (refer Fig. 4).

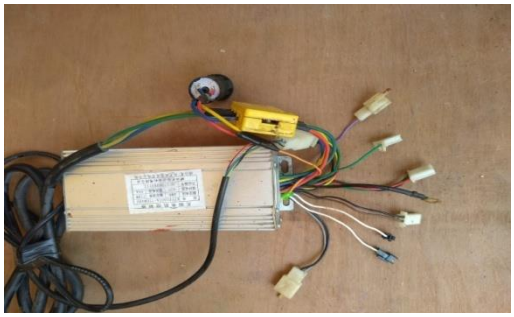


Fig. 4 BLDC motor drive controller

Table. 1 Specification details of proposed EV

S.No	Components	Specifications
1.	BLDC Motor	48V, 21A,750W, 2800 RPM
2.	Motor controller set	Low Power Unit
3.	Metal	Mild Steel
4.	Vehicle structure (Welding)	Mild Steel
5.	Battery	12V, 20 AH (Lead acid)
6.	Vehicle keyset	-
7.	Frame work	-
8.	Wheel	10inch.
9.	Wheel disc	-
10.	Front glass + Painting	-

The specification of designed EV is listed in Table 1. Also, the dimensions of designed EV are represented in both top and bottom view (refer Fig.4). The mechanical structure dimension of developed EV is selected based on Society Automotive Engineering (SAE) and also, contribute to the development of effective technologies which are important to the future of our country.

III.MATHEMATICAL DESIGN CALCULATION DESIGNED ELECTRIC VEHICLE

The mechanical structure weight and electrical system calculation of EV (refer Fig. 1) as follows;

No load speed calculation

Step 1

Number of Teeth on Smaller Sprocket (Motor) t_1= 13
Number of Teeth on Larger Sprocket (Vehicle) t_2= 44
Speed on Smaller Sprocket (Motor) N_1= 2800 RPM
By using reduction ratio (7) speed will be reduced to 400 RPM

Step 2

Using speed ratio formula,

$$N_1 t_1 = N_2 t_2$$

Speed of the wheel N_2 = 400 x 13/44 = 118.18 RPM

Step 3

Diameter of wheel =44 cm = 440 mm
Circumference of wheel = pi x D = 3.14 x 440 mm = 1, 381 mm

Step 4

Speed of vehicle = Speed of wheel x Circumference of wheel = 118.18 X 1, 381= 1, 63, 209 mm/min

Calculation of required power to drive the electric vehicle

Step 1

Total load act on E-vehicle as follow,
Net vehicle weight = 85 kgs
Average human weight = 160 kgs
Average luggage weight = 30 kgs
Total weight = 275 kgs= 275 x 9.81 = 2697 N

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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})= 2697/2 = 1348 N

Where reaction on rear and front wheel are as follows,

$R_{fw} = R_{rw}$ = 0.2x 1348 = 269.7 N

Step 3

To find torque on each wheel

Total torque = $T_{fw} + T_{rw}$

To find torque on the front wheel

$T_1 = R_{fw}$ x D/2 = 269.7 x 44 x 10^{-2}/2 = 59.18 Nm

Total torque on wheel = $T_1 + T_2$ = 118.36 Nm

Step 4

To find the power on the motor = 2xpix N_2 xT_1/60 = 2x3.14x118.18x59.18/60= 732 W

Battery capacity calculation

732 W EV is run for 1 hour. Watt-hours= 732 x 1= 732 Watt Hours. Account for the efficiency of battery, say 85%. Watt-Hours = 732/0.85= 861 Watt-Hours. Ampere Hour (at 48V) = 861/48=18 Ampere Hour (approximately 20 Ampere Hour).

IV. DISCUSSION ON FABRICATION OF ELECTRIC VEHICLE

In this section deals about the fabrication analysis of designed EV.



(a)



(b)

Fig. 5 Framework of proposed e-vehicle



Fig. 6 Fabrication of proposed e-vehicle

Fig. 5 shows the frame work of the EV. In this fabrication, mild Steel is used for the construction of the EV. The details of frame height and dimensions of wheel of EV as follows;

- The diameter of the shaft is: 1 inch
- Front wheel Diameter is: 40 mm
- Back wheel Diameter is: 40mm
- Distance from the ground to the vehicle is: 150 mm
- Distance from the ground to the roof of the vehicle is: 1760 mm

Frame: Metal used – MILD STEEL 410 PPM, weight of the frame = 53 kgs, Carbon steel is used to construct the vehicle chassis and the frame to achieve more light weight construction. Carbon steel is steel with Carbon content up to 2.1% by weight.

Fig. 6 show the complete fabrication designed e-vehicle.

V.CONCLUSION

The design and fabrication of EV for physically challenged person has been tested successfully. The designed model has excellent pulling capacity, modified mechanical, comfortable travel for physically changed person, simple maintenance, and minimal number of components in comparison with existing EV. The performance of the developed EV is tested at various running conditions for battery back-up and time durations. The designed mode is run for 7 to 10 kmph.

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