Design and Fabrication of Hands-Free Electric Vehicle for Disabled People

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Abstract*— The number of people using personal mobility vehicles is ever increasing. The development of such vehicles to address their needs are essential to their quality of life. People with disabilities mostly use wheelchair for their day-to-day activities. Problems with wheelchairs are that, they put stress on the user's upper limbs. Presently, hand-driven vehicles for people with disability in their lower limbs are easily available in the market, but fewer vehicles are developed for the people with disability in their upper limbs. Hands-free vehicle is developed for people with disability in their upper limbs and to provide user with improved levels of mobility, and providing freedom to travel on their own. The most important part of this project is the steering mechanism which will be operated fully with the help of legs. A battery powered engine is chosen for this design. The weight of the user which on an average is about 70 kg is considered here. The outcome of this project is to achieve a two-wheeler vehicle with foot operated steering mechanism for handicapped arm-less person with electric drive. The goal of this project is to create easy means of transportation for people having disabilities. There are different types of vehicles for disabled people that are available in the market such as petrol based two-hand operated bike, petrol based one-hand operated bike, wheelchair bike, hand operated two-wheeler bike with electric drive. Since foot operated vehicles designed for people with disability in their upper limbs are rare to find. So, we have come up with a design that addresses the problems faced by such disabled people to commute and also to reduce the cost of transportation by providing an electric drive instead of an IC engine. The foot operated mechanism designed for this vehicle provides an ease for the operator with disability in his upper limbs to steer the vehicle in the required direction. This will help them to commute to nearby market places for their daily activities. This would make them self-reliant and also, they may not have to face the discrimination as they would have faced otherwise while using public transport.

***Indexed Terms* — Accelerator, BLDC motor, Brake pedal mechanism, Hands-free electric vehicle, Steering mechanism**

I. INTRODUCTION

Disability in humans may be caused during birth which may be of physical, mental etc. The disabilities may also be physical, sensory, vision too. According to a survey conducted by the National sample survey organization conducted during the period of July-December 2002, it was found that the number of people having movement disability was found to be 23,557 in the rural areas whereas it is about 14,099 in the urban areas. The people with disability in movement are able to travel from one place to another by driving a vehicle for e.g., a tricycle designed for physically challenged or a two-wheeler vehicle with continuously variable transmission with dummy rear axle to provide balance for the driver. This idea came into picture by looking towards the people who are physically challenged due to accidents, military injuries etc. They always dream of driving cars, bikes but unfortunately due to disabilities they are unable to achieve their dream. Here in this project, we would like to go in for design and modification of a vehicle which can be controlled by legs instead of hands.

II. LITERATURE SURVEY

Jayaprabakar [1] the electrical bike designed here is four-wheeler with three rear wheels and one front wheel. And also, the vehicle has one carrier basket and two pillions for accommodating two persons and a driver. Electric vehicles (EVs) use an electric motor powered by electricity stored in batteries. The electric vehicle is aimed to have many advantages like little noise and zero emissions. And also, electric vehicles are designed to operate with more energy efficient than an Internal Combustion Engine Vehicle.

Amos G. Winter [2] the aim of this assessment was to inspect the current state of wheelchair technology from multiple angles by interviewing the primary parties involve with wheelchair design, manufacturing and use. Three types of questionnaires were developed by the author, in conjunction with TATCOT and WW1, to interview individual wheelchair users, wheelchair advocacy groups, and wheelchair manufacturers. In this paper the terms 'wheelchair' and 'tricycle' are both used to describe types of mobility aids

C.P. Venkatesh [6] this paper overviews the implementation of new conceptual ideas and technologies on handicapped vehicles for the betterment in the preexisting vehicle models for differently abled people and we hope this will be helpful for the further manipulation in developments and provide the guide line for the new innovations in automotive for the physically challenged people.

III. CONSTRUCTION

Frame is designed with due consideration to all the conditions. Construction of the frame, is basically a vertical hollow rod where one end is connected to steering arm using nut and bolt and to the other end, a horizontal hollow rod is welded. The horizontal rod is welded to the bearing. This bearing is fixed inside a hollow small cut pipe which is welded to the circular disc. This disc allows us to steer the vehicle in the left or right direction. L-shaped pipe is welded to the swing arm. The bearing for the side tires, outer race of the bearing is welded to the short circular pipe and the circular pipe is welded to the square bar. Inner race of the bearing is fixed to the shaft which allows easy attachment of the tyre when needed. Accelerator is mounted on the right side, on the vertical rod; Accelerator is basically a small plate which is mounted on the small horizontal rod. Accelerator is the controller. The output speed of the vehicle depends on the accelerator. Brake pedal mechanism consists of two stationary plates, one is mounted horizontally and the other vertically. E-shaped plate is welded and brake cable are passed through this E-shaped plate slots and the rod is pivoted to this vertical plate thus allows the rod to move back and forth thereby applying and releasing the brakes. The seat is modified by making supports on the sides of the seat for safety purposes.

Fig 1: Hands Free Electric Vehicle for Disabled People

IV. METHODOLOGY

Firstly, the vehicle is connected to a battery. The battery consists of two terminals namely positive and negative. The positive terminal is connected to the stator body of the motor whereas the negative terminal is connected to edge of the vehicle. The battery and the motor are connected in series. When the engine is powered through the current, the stator coil gets magnetized and the rotor shaft is made to rotate in the counter clockwise direction. Battery gives power to the hub motor, when the vehicle is accelerated a signal is sent to the controller, the controller then controls the speed of the rotor depending on the output given from the accelerator. The driver is seated in the vehicle with one foot controlling the steering as well as the accelerator on the right side of the vehicle and the other foot for applying the brakes on the left side of the vehicle. The seat is modified by making supports on the sides of the seat for safety purposes.

V. DESIGN

1. Mild steel (iron containing a small percentage of carbon, strong and tough but not readily tempered), also known as plain-carbon steel and low-carbon steel, is now the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Mild steel contains approximately 0.05-0.30% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing.

Table 1: Selection of structure

Structure	Weights		
	Plate	Hollow Square Bar	Pipe
Horizontal Component 1	155.009 g	110 g	52 g
Vertical Component	813.798 g	570 g	273 g
Horizontal Component 2	155.009 g	110 g	52 g
Tota	1123.816 g	790 g	377 g

As the weight of the pipe is less than other structures like Plate and Hollow Square bar, using pipe the overall weight of the structure is reduced and is also economical.

2. Calculations

Design of Pipe

Considering bending failure for Horizontal component 1 and 2

σ_b = Yield strength /FOS

Considering FOS= 2

σ_b = 370 /2 = 185 N/m

σ_b = (M y)/I

I= π /64 * (do^4 - di^4)

185 = (118.5*100*20/2*64)/π*(20^4 - di^4)

di = 18.88 mm

Thickness, t = 1.12 mm

For Vertical component the tensile stress acting on the component is negligible

σ_t = P/A

= 118.5 /π /4*(do2 - di^2)

= 118.5 / (π /4*(20^2 - 18.88^2)

= 3.464 N/mm2

As we can see that the TENSILE stress acting on the Vertical component is very less, design for the component is not required.

Design of rod

Considering compressive failure of rod

σ_c = P/A

σ_c = 370 /2 = 185 N/mm2

185 = 118.5 / (π /4*(d^2)

d = 0.9030 mm

Compressive stress acting on the rod is negligible

Forces acting on the rod in X direction, load due to swiveling movement of the mechanism which is = 30 N in Y direction, load acting due to placing of foot on the disc which is = 118.5N

Resultant force acting on the rod which can cause bending failure

R= $\sqrt{}$ 118.52 + 302 = 122.23 N

Considering bending failure of the rod

σ_b = M y/I

I = π /64*(d^4)

185 = 122.23*40*d*64 /π*(d^4)*2

d = 6.45 mm ~ 10 mm

3. Computer Aided Design

The designing of the CAD model was done on SoildWorks software. The CAD model for Scooter, Steering mechanism and Brake pedal is shown below:

Fig.2: CAD model of Scooter and Steering mechanism

VI. FABRICATION

1. Frame

Construction of the frame, is basically a vertical hollow rod where one end is connected to steering arm using nut and bolt and to the other end, a horizontal hollow rod is welded. The horizontal rod is welded to the bearing. This bearing is fixed inside a hollow small cut pipe which is welded to the circular disc. This disc allows us to steer the vehicle in the left or right direction. L-shaped pipe is welded to the swing arm.

Fig 3: Frame

2. Brake pedal mechanism

Brake pedal mechanism consists of two stationary plates, one is mounted horizontally and the other vertically. E-shaped plate is welded and brake cable are passed through this E-shaped plate slots and the rod is pivoted to this vertical plate thus allows the rod to move back and forth thereby applying and releasing the brakes.

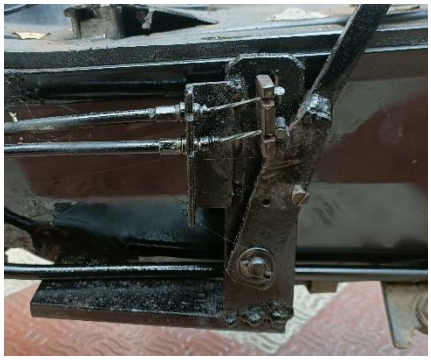

Fig 4: Brake pedal mechanism (E-shaped plate)

Fig 4: Brake pedal mechanism

VII. RESULTS

- Trial 1
- The bike with weight of 160 kg was driven for around 30 kms with an average speed of 20 km/hr with the battery fully charged.
- Trial 2
- The bike with weight of 155 kg was driven for around 42 kms with an average speed of 20-25 km/hr with the battery fully charged.
- The hands-free electric vehicle for physically disabled people has been successfully executed.

VIII. CONCLUSION

- The steering mechanism designed has operated successfully in swiveling the mechanism.
- The implementation of this project is highly cost effective compared to other handicap vehicles.
- According to the trials carried out, it is ideal for carrying a load of not more than 155 kg.
- These product gives the physically disabled people an exposure to carry out their needs on daily basis.
- Finally we performed all the necessary trials, the results obtained were analyzed and necessary changes were made.

IX. SCOPE FOR FUTURE WORK

- This project is aimed for the people injured or disabled by their hands and who are dependent on legs for their short distance commutation and other day to day activities. Therefore it can be improved by upgrading it with a battery of larger capacity and a hub motor of larger wattage for long distance commutation.
- This vehicle will be economical and there will be no contribution to air pollution, as it is electric.
- A seat belt arrangement can be provided.
- Reverse mechanism can be implemented.

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