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Hands-free Electric Vehicle for Disabled People

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Abstract - *For the growing number of people using personal mobility devices, development of devices that address their unique needs are fundamental to their quality of life. Traditionally those with mobility impairments have used wheelchairs to participate in activities. Two problems with traditional wheelchairs are the stress they put on the user's upper limbs and their inability to actively engage the lower limbs. The goal of this Project is to create easy means of transportation and commutation for differently abled people. Presently, hand-driven vehicles for people with disability in their lower limbs are easily available in the market, but very few vehicles are developed for the people with disability in their upper limbs. The aim of this project is to develop a vehicle for people with disability in their upper limbs and provide vehicle users with improved levels of mobility, facilitating freedom in travel and contribution to the community. The most important part of the design is the incorporation of the steering mechanism which will be fully operated by legs without any discomfort and to make life more comfortable for the physically challenged persons. The system is entirely dependent on sprocket chain mechanism for its steering purpose. A battery powered engine was chosen for this design and consideration was also given to the weight of the user in which a maximum weight of 70kg was used.*

Key Words: Hands-free Electric Vehicle, BLDC Motor, MOSFET, Chassis, Deep Groove Ball Bearing, Electromagnetic Interference, Controller, Sprocket Chain Mechanism, Swing arm

1. INTRODUCTION

This idea emerged by looking towards the people who are physically challenged due to accidental injuries, military warfare injuries, diseases, accidents, and birth defects. They always dream of driving cars, riding vehicles but unfortunately due to some reasons they are denied of these privileges. With this project we designed and modified a system to convert hand operated vehicle to a leg operated version. This project is aimed at the people injured or disabled by their hands and who are dependent on legs for their long distance commutation and other day to day activities. We specifically developed an affordable and rugged vehicle appropriate for use in a developing country like India. This meant designing with the use of locally available parts and manufacturing facilities. The basis of our designing made the Electric vehicle more of an appropriate technology because it uses a familiar, locally available platform as starting point.

The technical field relates to the hands-free motorbike for the physically challenged person. More specifically the project relates to foot control steering mechanism incorporated with a combination of accelerator and brake pedal. The invention further provides two additional wheels for safety and balance which is integrated to the rear end.

A national level survey conducted by the Government of India once in ten years revealed that, around 27 million people which are about 2.21% of the Indians are differently abled. Among them, around 14.98 million were men while 11.84 million were women. Also, the percentage of disabled people in rural area was higher than those in urban areas. A total of 5.43 million people were identified with disabilities in movement which was the highest among other categories such as hearing, seeing etc. in terms of numbers of people affected.

2. LITERATURE REVIEWS

Researchers nowadays are so advanced that innovations are happening day in and day out. Similarly, there is a huge improvement in the design of vehicles. Some of the literatures which include such improvements are reviewed.

2.1 Leg operated pedal mechanism

A legged control pedal mechanism for handicapped having a wire running through the upper steering rod end and up to idler pulley with the help of pulleys and pulleys support used to control the movement of the machine or vehicle in desired direction, applying brakes and provides acceleration to vehicle through operation of the pedal mechanism at leg position

2.2 Affordable electric vehicle for disabled people

The electrical bike designed here is four wheels with three rear wheels and one front wheel. Vehicle uses electric motor for propulsion and is made light weight. Vehicle is highly compact to enter the building and structures like industries, Hospitals, indoor and outdoor place. And also, the vehicle has one carrier basket and two pillions for accommodating two persons and a driver.

2.3 Hand free tricycle for disabled people

Vehicle was designed for physically handicapped person who has to control vehicle using legs. The invention through this system is entirely dependent upon the sprocket chain mechanism of bicycle for steering purpose. The project also provides two wheels at rear side for safety purpose.

3. METHODOLOGY

I. Literature review and recognition of scope
II. Design
III. CAD modelling
IV. Simulation and analysis
V. Fabrication
VI. Implementation and testing

4. DESIGN STAGES

A. Design of Steering mechanism

The steering mechanism consists of a steering rod which is nothing but the vehicle handle and an operative rod which is mounted in two bearings attached to an 'L' shaped connecting rod. Also it consists of two sprockets and a chain to transmit the motion from the operative rod to the steering rod. The two sprockets are attached at the upper ends of these rods in such a way that, the rotation of one will lead to the rotation of other.
A pedal mechanism is provided at the bottom of the operative. The operative rod which mounted in two bearings is connected with the steering rod with the help of an 'L' shaped connecting rod which is welded at its two ends respectively

Working:

The steering mechanism of this vehicle is based on a simple 'Push and Pull' theory. A bicycle handle shaped rod is attached at the bottom of the operative shaft which facilitates turning of the vehicle.
Hence, the to and fro motion of the rod i.e. the push and pull of the rod will lead to the vehicle turning right and left respectively. As the operative shaft is free to rotate in these two bearings the translatory motion of the rod leads to the rotary motion of the operative which ultimately leads to the steering of the vehicle.
This rotary motion is transmitted from the sprocket attached to the operative shaft to the sprocket attached to the steering rod with the help of a sprocket-chain mechanism. Hence the anti-clockwise rotation of the operative sprocket will lead to rotation of the steering sprocket in the same direction thus rotating the wheel. Thus, the steering of the vehicle is operated with the help of a 'Push and Pull' mechanism which is based on the simple laws of physics

4.1 Calculation of steering mechanism

Angle through which wheel can be turned in one side = α= 40°

Arc travelled by small sprocket = angle*radius of small sprocket

= 40*π/180*38

Arc travelled by small sprocket = 24.43mm

So arc made by big sprocket will also be 24.43 mm

Radius of big sprocket = 70 mm

Angle made by big sprocket will be β

24.43 = β*(π/180)*70

Angle made by big sprocket at one side = β = 20°

Therefore total angle made by big sprocket∴2β=40°

Rod connected to the bigger sprocket has diameter of 20 mm

Therefore radius = 10 mm

Arc travelled by the solid shaft = radius*2β

= 10*(40*π/180)

Arc made by solid shaft = 6.98 ≈7 mm

If we fix the perpendicular length of rod as 100mm

So the arc made by rod will be r=length of rod*2β*π/180

∴r=100*40*π/180

Therefore arc made by rod = 69.81mm ≈70mm ≈7 cm

4.2 Calculation of length of chain

No. of teeth on small sprocket = T1 = 18

Pitch diameter of sprocket is given by pitch/sin (180/T1)

Where T1 is no of teeth on small sprocket

Outside diameter of the sprocket = pitch*(0.6+cot (180/T1))

Pitch of the sprocket is given by = 2*radius of sprocket*sin (θ/2)

= 2*38*sin (20/2)

Pitch of the sprocket = p = 13.19 mm

Center to center distance = c = 170 mm

No. of teeth on big sprocket = T2 = 28

No. of links in chain is given by=k= (T1+T2)/2+ (2*c)/p+ ((T2-T1)/2π) ^2*p/c

K= ((18+28))/2+ (2*170)/13.19+ ((28-18)/2π)^2*13.2/170

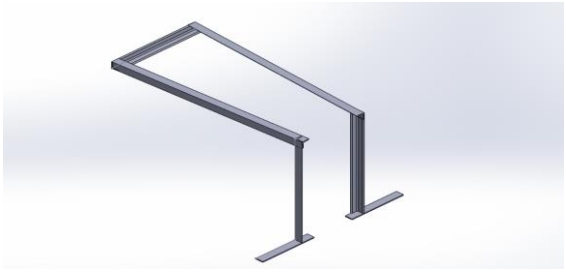
K = 48.95 ≈49 no. of links

B. Design of Side wheels frame

Side wheels were attached to the main body of the vehicle with the help of a frame. The side-wheel frame was designed keeping in mind the overall structure of the vehicle. The frame primarily consisted of a two parallel L- angle brackets connected by a horizontal L-angle bracket. All the brackets were connected to each other with the help of welding. Further, the brackets were fitted with two hollow circular rods of diameter 6cm each at their mid-sections. These circular rods were then tight fitted to the side-wheels of the vehicle which would then help in maintaining the balance of the vehicle.

C. Design of Seat frame

The seat frame of the vehicle was initially designed on solid-works. Further the CAD model of the seat frame was tested keeping in mind the ergonomics of the vehicle. The seat of the vehicle was supposed to provide support and comfort to the driver at the same time it was necessary that the seat was satisfying the safety requirements for the timely evacuation in case of an emergency. The frame was fabricated with the help of L-angled bars composed of mild steel. Two 90degree angles were made with the help of these bars which were attached to each other with the help of a horizontal bar. The lower and upper ends of this frame were bolted to the body of the vehicle whereas the middle section was covered with the help of a rectangular wooden plank on which the driver was supposed to sit. Further two inclined bars were bolted to the vehicle body and a rectangular wooden plank was attached to its upper section which acted as the back rest of the seat.



5. FABRICATION AND IMPLEMENTATION

The fabrication of Hands-free Vehicle for Disabled People has been was done successfully within desired values and paramters. The machining operations undertaken include Cutting, Drilling, Grinding, Turning, Arc welding etc.

Further the project was subjected to manual testing which provided us positive results.The vehicle tested positive on various parameters like accelerator, steering control, braking and vehicle body balance. The vehicle was designed and fabricated to bear a load of 110kgs, which was successfully beared by the vehicle.

6. RESULTS

- Hands-free electric vehicle with suspension has been designed and fabricated.
- Project has been completed in the targeted budget.
- Turning mechanism different than other handicap vehicles has been successfully designed and fabricated.
- Our vehicle causes zero pollution as compared to other handicap vehicles.
- Our vehicle runs on a motor driven by four 12 V batteries connected in series.
- Our vehicle has a better balance as compared to other handicap vehicles.

7. CONCLUSIONS

Thus, Design and Fabrication of a Hands-free Electric Vehicle for Disabled People has been successfully completed fulfilling the objectives stated at beginning of the term with desired results.

8. FUTURE SCOPE

• We can further modify this vehicle to make the handling easy and its efficiency can be improved, also with the help of future modifications the vehicle can be operated with the help of voice commands & gestures.

• The vehicle can be further modified to suit different applications.

• Motor of higher power can be mounted so as to increase its speed.

• High power batteries such as lithium ion batteries can be used to increase its life span.

• It's turning mechanism can be modified and more smooth turning of the vehicle can be achieved to make drive of this vehicle more comfortable with the help of rack and pinion or bevel gear modifications.

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