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Design and Development of Vehicle forArmless Physically Challenged Persons

[1].S.Rajendran, [2].V.Chokkalingam, [3].D. Loganathan, [4].M.Arulmurugan, [5].G. Murugesan

1,2. Professor, Department of Mechanical Engineering, Jaya Engineering College Chennai 602024, INDIA.

3. Professor, Department of Textile Technology, Jaya Engineering College Chennai 602024, INDIA

4. Associate Professor, Department of Mechanical Engineering, Jaya Engineering College Chennai

5. Assistant Professor, Department of Mechanical Engineering, Jaya Engineering College Chennai

Email: r9551329915@gmail.com

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Abstract
Transportation is one of the most important sources for increasing mobility of humans and it plays a major role in human life. Normal human being uses vehicles easily but for a disabled person it is not possible. There are many ways to make transportation easier for the people with disabilities who may wish to drive by themselves as others on the road. People with disabilities in limbs have difficulties in travelling and cannot travel long distances. They use devices such as wheel chair, crutches, and artificial limbs for mobility. These cannot be used for long distance outdoor transportation. Modification of standard production vehicle with experimental setupenables Physically Challenged person to drive vehicles by themselves without anyone's help. Various vehicles are available commercially for person withdisabilities. Our focus is on persons who lost their hands and wish to drive vehicles on their own.

1. INTRODUCTION

Transportation has become an integral part of people's everyday life. New and existing adaptive methods continue to increase opportunities for people with disabilities to drive both safely and comfortably. Some of these adaptive technologies are providing mechanisms for more convenient access. Others, such as easy controls, are necessary for a driver with disability to safely operate a vehicle. Whatever the requirements, chances are good that equipment to support their special driving needs are developedthat allows them to maintain the freedom offered by the open road. While there are many public transportation facilities that the persons with disabilities can avail, none of them offers the comfort and flexibility of a self-driven road vehicle. While road vehicles offer a means of transport for disabled person, they also carry psychological benefits. The ability to drivea motor vehicle can radically alter the quality of life led by disabled peopleas inability to drive causes brooding and frustration when they cannot do a useful day's work or occupy themselves. Well-advised disabled

drivers candrive to offices, shops, and cinemas without the need of a helper.

PERSONS WITH DISABILITY

Person with disability (PWD) is a person with physical or mental condition that limits his or her movement, senses or activities. People livingwith disabilities could be classified into two broad categories - Mobility Impaired PWD, Sensory impaired PWD. Sensory Impaired is referred to a person who, due to physical deficiency of any sensory organ is limited or incapable of understanding and carrying out certain activities like deaf, blind, autism, etc. Mobility Impaired is referred to a person who, due to the physical deficiency of any of their limbs is limited or incapable of carrying out physical activity. Examples of mobility impaired include cripple on one legor both legs, loss of one or both hands, etc.

Tatyaso A.Garande et al, This paper discussed the various modes of transport available and suitable for physically handicapped persons for long and short distance travel. The modes are classified as per the maneuverability, ease, automationand comfort. Various machines used for travelling of disabled persons include wheelchair, automatic wheelchair, Smart wheelchair, retrofitted vehicles, tricycles, modified cars. Systematic comparison of all these vehicles is carried out in this paper. Rashmi Urdhwareshe et al, Establishing National Approval Scheme for modifications to Vehicles Driven by Physically Challenged. Po Er Hsu et al, Mobility Assistance Design of the Intelligent Robotic Wheelchair. Leishman et al, This paper described the implementation of assistance to the driving of a smart wheelchair through a deictic approach. Initially, a state of the art of mobility assistance, interfaces and types of commands for smart wheelchairs is presented. The deictic concept and more particularly, the approach used for the design of interface are examined. Then the two functionalities carried out to implement this type of interface, as well as methodology used to control wheelchair are illustrated.

Ethirajan Bhaskaran, The primary objective of this project was to develop a vehicle for Disabled Persons especially for people without legs. Here, handle bar is used with accelerator and brake incorporated. The Permanent Magnet Direct Circuit (PMDC) Motor is used in the brake drum driven by battery. Current since this is a vehicle primarily designed for Disabled Persons, the vehicle is designed considering their disability in mind and much importance is given regarding the safety of the passenger after. Hence driverergonomics plays a key role in the designing of vehicle for legless persons.Handle bar designed to suit both manual steering and electric steering. Chassis design and center of Gravity is calculated and the Brake is kept in the Handle Bar. Loi, K The authors of this paper discussed the new standards of tourism development on critical issues such as quality, sustainability, image, innovation and accessibility.

S S Tachakra, The paper discussed the psychological benefits of riding vehicle for persons with disabilities. Also, the author describes the various modifications and driving aids that can be done to existing cars. The authoralso discusses the various types of disabilities and the impact they could have on the livelihood of the persons. Arun Raju.C et al, This study aimed at designing and fabricating a 3-wheeler with dual steering system for people with locomotive disabilities and armless people.A greater steering effort is required in the case of

a four-wheeler compared to a three-wheeler.

2. PROCESS METHODOLOGY

This stage identifies the requirements of the prospect. It answers the 'What', 'Why' and 'How' of the need at hand. It looks upon the presentneeds and problems of the past to arrive at better results for the future.

Material Selection

Material selection is a step in the process of designing any physical object. In the context of product design, the main goal of material selectionis to minimize cost while meeting product performance goals.

Machining

It is a part of the manufacture of products by various machining methods like drilling, turning, grinding, etc.

Assembly

It is the process of sequential organization of parts where various components are brought together in a sequential manner to achieve the finalproduct.

Calculation

It is the process of using information you already have to determine unknown variables.

3. DESIGN PARAMETERS

Handless operation – By removing the dependency of using hands to operate motorcycle completely. This includes starting the vehicle, accelerating and breaking the vehicle, turning the vehicle and stoppingthe vehicle all without using hands. The effect of inertial 'g' forces can be minimized by adding provisions like seat support for the spine to prevent backward push onthe rider while accelerating and making an inclined footrest upon which the rider can press for support whenever the brakes are appliedto minimize the effects of forward pushing forces. Ease of use – By making all the buttons and switches reachable and easy to trigger by the rider without sacrificing on the consistency of acceleration and steering. For handless operation we planned to use a chain and sprocket mechanism that connects the front steering column to a special steering assembly fitted with footrest and pedals that allow for acceleration and brakewith legs.

Steering hub

The steering hub will serve the purpose of translating the working of a hand operated handlebar to a foot operated steered. We thought of several mechanisms including one where two links extending from either side of the front axle to the rider that can be used to steer the vehicle, but none of them would offer any stability to the rider and would only result in discomfort. So, we went for a chain and sprocket mechanism which soundseasy on paper but was difficult when actually implemented. The idea is that when the rider turns a freely rotating

assembly withhis foot, the torque applied by the legs is transferred to the steering columnand becomes the steering torque. The steering assembly is designed keeping in mind the amount of torque that would be required to steer the vehicle. The span of the footrest is only slightly smaller than the actual span of the handlebar. This means that only a slightly higher torque should be applied to the steering assemblyby legs because less length means more torque for the same amount of force.Also, the gear ratio employed here is 1:1.3 meaning for every turn the steering assembly makes, the steering column will make 1.3 turns. So, the rider has to steer only to a small extent and can still achieve steep steering. The placement of the steering hub is at the front region of the floorof the vehicle with a slight inclination. The inclination of the assembly should be such that the steering sprocket is on the same plane as the front sprocket joined to the steering column as shown in the figure 1.

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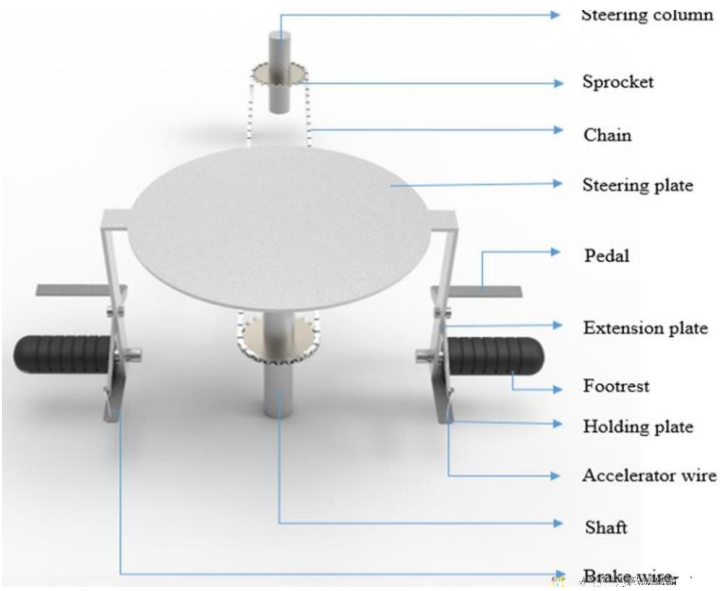

Figure 1 3D model of Steering Hub

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Figure 2 3D model of Steering Hub placement in vehicle

As shown in the figure 2, the hub placement should be well within the reach of the rider and also have enough span to generate adequate steering torque for the force applied. Also, the inclination of footrest allows the rider to press for support whenever the brakes are applied to minimize the effects of forward pushing forces whenever the brakes are applied or when the vehicle decelerates.

4. Pedal Arrangement

The pedal needs to be placed near the footrest and should be madeto rotate alongside it so that the rider can achieve consistent steering when accelerating and braking. Also, the pedal should be able to displace the wireby a certain distance so as to achieve throttling and braking. The first condition is met by making the front half of the pedal lever (the part that holds the pedal) shorter than the rear half of the pedal lever (the part where the brake and throttle wires connect). Due to this, a small displacement on the front end of the lever can cause a large displacement on the rear end of the lever. Steering Velocity

For a vehicle making a turn, it experiences a radial (inward) acceleration. For a two-wheeler this inward acceleration is compensated byleaning the bike away from it. However, in a bike with side wheels attached leaning cannot occur and the traction in the tire when turning depends only on the friction of the tire material, the steer radius and the steering velocity. When the vehicle is making a turn at a velocity v and a radius r, theside force is mass times inward acceleration

$$F = mv^2/r$$

The frictional force available to prevent sliding is

$$F = \mu \times m \times g$$

Therefore, sliding can be avoided only when the side force is less than or equal to the frictional force.

Steer radius of bike = 3m

Mass of the bike + rider = 80 +70 = 150 kg

Friction between the tire and asphalt μ = 0.75

$v^2 \leq \mu \times g \times r = 0.75 \times 9.81 \times 3 = 22.07\ m^2/s^2$

$v \leq 4.69$ m/s = 16.88 km/hr.

Turning the vehicle with a velocity above 16.88 km/hr for 3m radiuswould result in sliding of wheels.

CONSTRUCTION

We made significant progress in the past few weeks in the development of the handicap vehicle. Each section of our project has been planned out and finalized. Even though we had some now at times, the project came out very well. The details of the plan, which will be discussed below, follow some original thoughts but also include some significant design changes to maximize the performance.

Side Wheel Attachment

The vehicle that we used was a 2004 model TVS scooty ES whichhas been discontinued a long time ago. We were not able to find the correctside wheel attachment for our vehicle so, we bought the one for a scooty pepmodel and then we had to cut and weld at a few places to get the right fit. We also drilled holes in the foot floor to fix the side wheel attachment. Even though the wheels were at the right size, the regions that didn't fit were the front extending beam and the two rear hollow tube links at the rear. We used an electric saw (355mm) and then used arc welding to join the shortened links.

Steering Hub

The steering hub is the main part of our project and it was necessary to get the right size and inclination so that the whole system couldwork without any problems. The steering hub itself comprises several partsas listed. Base plate upon which the whole steering assembly rests. Base hub that connects the rotating shaft to the stationary base plate. Shaft – A rotating element to which the sprocket and steering plateare connected

Base plate

Mild steel plate of dimensions 200mm × 150 mm and thickness20mm is used for the base plate. The plate was cut down to 200mm × 145 mm and thickness 20mm in a horizontal gear type shaper machine. In addition, the plate was tapered on one of its faces (bottom face) to get the right amountof inclination for the steering hub. The taper was also done on the same shaper machine. The reason for providing the inclination is to make the sprocketin the steering hub

align with the sprocket in the front steering column. Also,the inclined steering hub placement gives an added comfort and support to the rider especially when decelerating or when making a turn. Holes are alsomade on the platform such that the base plate can be bolted to it.

5. CONCLUSION

New technologies are being developed day by day to allow persons with disability to utilize the road transport on a self-driven vehicle. We haveaccomplished our objective of developing a setup that would be easy for the armless person to operate with their legs and used it as a modification for an existing vehicle while keeping the cost down. We hope that our work would help the differently abled persons to not only ride a bike without anybody's help but also break free of the unhealthy psychological effects born out of the feeling of inability to perform activities like an ordinary person.

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