Design and Fabrication of Drivable Wheelchair Attachment

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ABSTRACT: ***Wheelchairs are being used for movingpatients in hospital as well as handicapped people for the last six centuries. Wheelchairs are propagated by human strength. The handicapped peoplemove wheelchairs by the use of their upper limbs or in other cases another human is needed to push their wheelchair forward. Here we propose a pretentious detachable extension which can be connected to a wheelchair and can convertnormal wheelchairs into powered oneswhich do not need humans to apply force to propagate. At the same time,this system uses batteries to move the wheelchair and in turn no fuel is needed which makes it a green vehicle. This powered wheelchair extension is designed to power normal wheelchairs and so, it achieveseffective and easier propagation method forthe patients andhandicapped people as well. This extension uses metallichollow pipes and rods together as asystem which is designed to attach to a wheelchair's front pipe and thus clamp on it. We also use pipes and bearings connected handle designed in order to achieve motion in multiple directions. Our team is currently pursuing a chain-drive systemwhichtransmits the power of the motor to the driving wheelfor providing the motion of our extension. The extensionutilizesmultiple rechargeable batteriesin order to transmit power to the motor and a switch is placed in order to turn the power on or off and also, to change the movement to forward or reverse.***

Therefore, using this extension, wheelchairs will be utilized by the patients and disabled directly in order to move over shorter routes without being dependent on other human beings. Some researchare also being conducted in order to enhance the current design for making the extensionmore comfortable and more safety features can also be added in the future.

I. INTRODUCTION

Existing Modelsof Drivable Wheelchairs

Tricycles for Handicapped are modified tricycles which are driven by hand peddles instead of legs. One hand is used to rotate the peddle ,and the other hand is used to steer the tricycle. These are the cheapest option available in the market. Electric Wheelchairsare more popular variety of wheelchairs worldwide but in India, they are not so popular due to there high price range. They allow the people with disability, the freedom of mobility without having to rely on anyone, except for getting into the wheelchair. Multi-wheeled Scootersare just ordinary scooters with two extra wheels attached between the front and rear wheels to prevent the disabled people to get from one place to another without tipping over.

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They consist the cost of the original scooter as well as the cost of extra set of wheels. So, they are slightly on the expensive side. Hand Lever driven Wheelchairs a minor attachment to the manual wheelchairs which consist of a set of gears and a lever connected to the wheelchair on either side. The person can move forward or backward by continuously stroking the lever irrespective of the direction.

Problems regarding current drivable Wheelchair Systems

Current wheelchair models which can be driven from one place to another are on a higher price range. So, not everyone can afford them. Scooter side wheels are also costlier as they are an actual set of extra wheels and they are costly. Existing wheelchair models have very little to no suspension. This can cause spinal cord injuries to the disabled person. Spinal cord injuries can lead to death within two years.Hand driven mechanisms in wheelchairs can also lead to continuous pain in shoulder, elbow, wrist and hands. This can lead to loss of motor nerve functions among these body parts and can cause the person to be paraplegic. The disabled person has to depend on someone to put them in the wheelchair if they want to move around. This leads to less mobility and decreased mobility causes Pressure sores and Osteoporosis that can lead to 3.73 times higher risk of limb fracture compared to people with good mobility.

The available attachment options available for manual wheelchairs to make them drivable are also in the higher price range, with the average price being 67,000 rupees.

Driving Characteristics of Electric Wheelchair Users

The target was to regulate the driving features of rechargeable wheelchair operatorsthroughoutunobstructedpublicactions and to equate the movementpointsamongst a dynamicassembly and a set of steadyoperators. Information was composed in the societies of Pittsburgh and San Antonio, Texas. 120 individualscontributed, all of whom utilizedpower-driven wheelchairs as a mainmedium of movement. Data loggers and sensors were installed on the wheelchairs. Speed, distance travelled, and time spent on wheelchair was monitored 24x7 for 5 days. The San Antonio group travelled an average of 16,174m per day for 7 days while the Pittsburgh group travelled 15435m on average. Along the 7-day time of the learning, there was a slightdisparity in swiftness and total lengths covered per day. Drivers were most active during afternoon and evening hours. The wheelchair drivers in San Antonio were found to be more active than their Pittsburgh counterparts during a typical work week.

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Outcome of Electric Wheelchair Impulsion on Shoulder Thrust in Veteran Wheelchair Operators

This is anevaluationamongarm-driven and electric wheelchair thrustwhereasdriving on a treadmill. Electric wheelchair thrust is operative in droppingpossiblehazardissues of shoulder abusedamages: concentration ofshoulder charging, shoulder viewpointsthroughoutpower generation, shoulder variety of movement, and strength of muscle initiation. The preparation of electric wheelchair appears to be designated for focusesevolvingmisusedamages due to arm-driventhrust or focuses with problemsmovingan arm-driven wheelchair mainlyowing to absence of upper limbcontrol. 31veteranelectric wheelchair operatorspushed a sensor fitting wheelchair on a treadmill while upper-limb kinematic, dynamic and external electro-biographic data was composedthroughoutthrust with and without electronic-assistance. As anoutcome, throughoutelectronicmomentum, the ultimateresultingenergyexercised at hands reduced. At shoulder state, the forwardfocusedstrength, interiorspin and flexion twistreducedsuggestively. In decision, equated to arm-driven momentum, electricmomentumappearsoperative in droppingpossiblehazardissues of abusedamages with the maximumadvance on reducedvariety of movement of shoulder joint, truncatedultimatemomentumstrength on the hand, and condensed muscle action.

Design Topographies that mark the Movement of Wheelchairs

The aim was to govern the lowest space compulsory for maneuveredmovement device operators to do11 maneuverability errands and to examine the influence of designatedprojectcharacteristics on space. The trial of suitabilitycomprised213Physical Wheelchair operators and 117Motorized Wheelchair operators. A fakesituation was created to makehallways to formulate an L-turn, 360° shot in place, and a U-turn with and without a barricade.Hallwaybeginnings were augmented in 7 cm additionstill the operator could effectivelydorespectivelyjobdeprived ofstriking the stockades. Physicalextents of the expedient and operator were composed using an electromechanical probe. Ultralight Physical Wheelchairs with backaxissubsequent to the shoulder had the directdistances and obligatory the slightestquantity of space equated to all extrakind of Physical Wheelchairs. Mid-wheel-drive Motorized Wheelchairs neede the smallestquantity of space for 360 turn in place equated to front-wheel-drive and rear-wheel-drive Motorized Wheelchairs but achievedcorrespondingly as well as front-wheel-drive representations on all additionalwhirlingerrands. Amid 12%-91% of operators would not be able to move in spaces that happen the presentConvenience Guidelines for Buildings and Facilities specifications.

Solution of Problems regarding Current Drivable Wheelchair Systems

We are planning to fabricate a separate drivable attachment which can be fitted directly to the wheelchair as it will reduce the cost of Powered wheelchair mobility and make it more affordable. As the current wheelchair systems have very little to no suspension, it leads to the cause of spinal cord injuries in disabled people. To eliminate the chances of these injuries, we are also planning to include a suspension system in the attachment and maybe to the wheelchair later on.As the attachment will fit directly to the wheelchair whenever necessary, this will allow the wheelchair users complete mobility without being dependent on people pushing the wheelchairs all day.Due to this project being a drivable attachment which will run using an electric drive, similar to gearless scooters, it will not require the wheelchair users to push the wheels with their hands all day, and hence, it will not cause pressure on hands and shoulder pain. Besides these solutions, the system will be eco-friendly as it will be running on batteries and it will provide users good maneuverability including mobility in left and right directions similar to the tricycles and scooters for disabled people.

Statistics regarding disability by WHO and UNESCO

According to theGeneral Population Census of 2011, in India, out of the 1.23 billioninhabitants, about 34.3millionpeople are handicapped which is 2.78% of the total population. 1428 road accidentshappeneach day in India. Tamil Nadu is the state with the extremeamount of highwayaccidentwounds. The World Bank and other establishmentsguess that there are as many as 569 million people with incapacitieseverywherein the world, making them one of the majormarginalsets of unserved, sidelinedfolks. Around590 million individuals in the world involveincapacities of numerouskinds. 83% of the world's injuredindividualsliving in low-incomerepublics; the popular of them are underprivileged and do not have admittance to rudimentaryfacilitieswithrestorationamenities. Nearby to nine million harshly or temperatelyinactivatedindividuals are supplementaryrespectively year to the entireworldwidenumber – or around 25,790each day. 78% of handicappedindividuals in emergingnations are projected to animate in countrysideparts.

The WHO projected that only 2-7% of individuals with infirmities who need rehab services have admission to them. Utmostfolks who bear a backbonetwine injury, die within 3 years equated to a usual life expectation.

Study on Manual Wheelchair Use

A training was directedaround the methodindividualspracticemotor-powered wheelchairs in their day-to-day lives and the particulars were as follows: A suitabilitymodel of 39grownups who used physical wheelchairs as their mainmovement devices were employed for this training with IRB support. These 39contributorsencompassed of men and women, ages from 21 to 68 years with an average age of 37.3 years. Initially, these folks used physical wheelchairs as their mainmovement and pushed them with upper limbs. The study was conducted for 370 days. On average, the daily usage of manual wheelchairs as primary mode of transportation lasted 21 seconds and the distance travelled was 8.6 metres.

Then, they were provided with wheelchairs with motorized attachments and the study was conducted again. This time, the study of wheelchair use for primary mode of transportation was conducted for 278 days.The average daily occupancy of wheelchair this time was found out to be 11.2 hours, with people occupying the wheelchair from 11 minutes to 24 hours. The average distance travelled was 1.6 km daily with average time spent on using wheelchair as transport being 54 minutes. This study shows how motorized attachments are better the manual usage of a wheelchair for a disabled person.

Repetitive Strain and Injuries among Manual Wheelchair users

The shoulder is the utmoststatedplace of musculoskeletal damage in physical wheelchair operators. Studiesdisplay the occurrence of shoulder aching to variety between 37-69%, liable on the topicset. This occurs due to nonstoppractice of hands to transfer the wheelchair from one location to one more over aextended period of stretch. 68% of the folkscomplaining shoulder achingestablished spinal cord injuries. Though shoulder aching is the greatestusuallystateddiscomfortamongstphysical wheelchair operators, wrist, jostle and hand linkeddiscomfort has also been described. The jostle, wrist and hand discomfort have been stated in 11%, 14.3%, and 9.5% cases correspondingly. By means of these numbers, the occurrence of upper body discomfort was 28% five years afterwound and 49% inside 15 years of damage. Throughouttransmissionconcerning wheelchairs, the burden on the linkages was originate out to be 2.5 times the characteristiccompression. Muscle disparity, triggered by misuse of these wheelchairs can lead to irregular biomechanics and thus, wound. Folks with muscle inequities are thus, not able to deliverdownhillpowercompulsory to push their wheelchairs advancingdeprived ofsupportingdiscomfort in their upper body limbs.

RESEARCH CONTEXT

Research performed in the present scenariodetailed that the most prominentresolutions which providenon-dependent motion in wheelchairsconsist of battery-poweredones and the ones which are propagated using a single hand. However, E wheelchairs are rather costly, need sudden lifestyle changes to be made while single armmotion extensions to normal wheelchairsare also costly and require major muscle synchronization or obstinate motion to move and control the wheelchair, which leads to tiredness, as establishedovertalking with numeroustherapy engineers and physical counselors.Because presentsingle arm driving extensions for wheelchairs do not offercheap and effectiveresolutions that providehumans with hemiplegia betterindividuality, there is a necessity in the scenario for a drive extension. In our project, we object to report these inadequacies and offer a strongresolution to accomplish this requirement. Therefore, our aim is to consentpersons with hemiplegia to propagate with comfort by manufacturinganreasonably priced and robust wheelchair movementextensionproficient of being inducted to numerousphysical wheelchairs.

1. FINAL DESIGN DESCRIPTION

Our approach consists of a handle based driving system, similar to those of scooters and motorbikes consisting of an accelerator used to control the
maneuvering the driving wheel. The driving part is performed by the usage of multiple motors based of the designed weight calculations. These motors are in turn driven by the power provided by rechargeable battery. An easy way to couple the attachment with the wheelchair is by welding a rod below the footrest of the wheelchair. This rod will be attached by using a coupling using a spring mechanism.

II. PROJECT SPECIFICATIONS

For this project, we are planning to use a 300W, 12V brushless motor which can be useful for carrying the wheelchair itself and the weight of an average disabled person. To run this motor we are using two rechargable batteries with a combined power rating of 48V and 24Ah. These batteries, if fully discharged will take upto 4-5 hrs using domestic power supply and have a range of more than 30 kms at a speed of 25 km/h. Using two batteries is very helpful in this project as we are combining them in a manner inwhich if one battery is operational, then the other battery will be charging at the same time simultaneously. We are planning to build this attachment using a frame made from Aluminium 6061 for pulling a combined weight of around 128 kg.

III. DESIGN CALCULATIONS

To find the force of the motor

Power (HP)= force (LBS) * speed (mph)/375

Power = 12v*5=60 W

Power = 0.0804 HP

Speed= 3.14*D*N/60

Speed = 3.14*60.5*65/60

= 205.9 mm/s 1mm/s=0.0022369mph

= 0.46 mph

Torque transmitted by the gear

Tangential force acting on the gear at the pitch line

f_t=1000n

Torque to be transmitted

$m_t=f_t$ x d/2 [d=m x z_1

m_t=1000x0.06/2 =3 x 20

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m_t =30nm =60mm]

Design torque

$[m_t]=k.k_d . m_t$

$[k.k_d$ =1.3 refer PSG Design Data book]

=1.3x30

=39nm

Center distance calculation

Center distance $a \geq (i+1) \sqrt[3]{((0.7/\sigma_c)^2 \times e_{eq}[m_t]/i\psi)}$

Where ψ=0.3 [refer PSG Design Data book]

$a \geq (i+1) \sqrt[3]{((0.7/600)^2 x\ 1x10^5 \times 39 \times 10^3/3 \times 0.3)}$

a≥ 72.27

a= 73mm

Revision of centre distance

CENTER DISTANCE $a=m(z_1+z_2)/2\cos\beta$

=3(20+60)/2x cos20

= 128mm

THEREFORE, THE DESIGN IS SAFE

Calculation ofb, d_1, v and ψ_p

FACE WIDTH $b= \psi \times a$

= 0.3 x 73

= 21.9mm

PITCH DIAMETER OF PINION $d_1 = m.z_1/\cos\beta$

= 3 x 20/cos20

= 64mm

$\Psi_p=b/d_1=0.342$

2. DESIGN APPROACH

All the designing process was performed using DS Catia. The designs which are depicted here are preliminary designs and are subjected to change if the projected is updated in the future.

Two-Dimensional Design

The two-dimensional designs are shown below in Side view, Top view, Front view, as well as orthogonal view. The designs shown are scaled to 1:6 ratio.

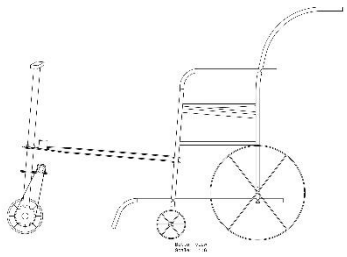

FIG: Side view of the project

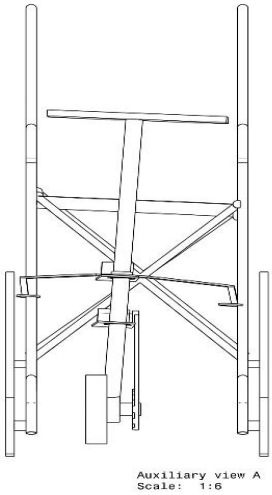

FIG: Front view of the project

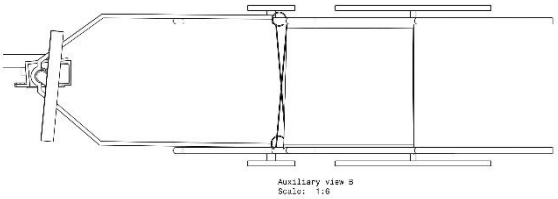

FIG: Top view of the project

Similarly, an orthogonal view was also constructed in 2d using the same constraints in order to show the clarifications in design.

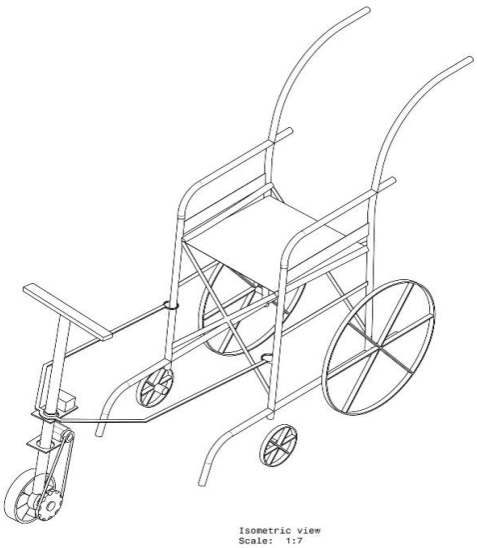

FIG: Orthogonal view of the project

Three-Dimensional Design

Similarly, a 3d design is drafted and assembled using the same software, i.e. DS Catia. Furthermore, an analysis based on stress can be performed on the 3d design using the same designing constraints.

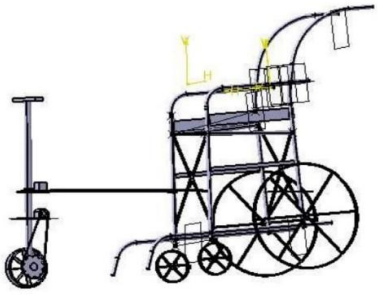

FIG: 3d design of the project

IV. OUTCOME

The newestmodelpurposes as intendeddeprived of any unexpecteddifficulties. It lets the wheelchair turn 45degrees to the left and 45degrees to the right. The wheelchair can also be moved by a person with the extensionconnected. We also erudite that numerousphysical wheelchair operatorspush themselves back, particularly when working up slopes. Therefore, we will make certain our expedient is proficient of helpfulstrongonward and regressivedrive. In adding, the foot lever should be swiftly stowable and the expedient should be out of the way for cases the operator wants to use his durable foot against the ground. This is sincefolks'twitchretrieval their fortes from their legs and the controldesiressatisfactory hand switch that comes in the concludingphase of reintegration. Thus, our crewtactics on leadingmorestudy and speaking to more physical psychoanalysts to choose the need of the control. We tooplot on bestowing our futuremodels to individuals with hemiplegia to increasereaction.

V. FUTURE SCOPES

Furthermore, multiple battery recharging options can be applied to the project in the future. One such example is Solar Panels. Solar panels can be utilised as the roof of the project and can be motorised to move to and fro in the direction in which the solar intensity is maximum. Also, Kinetic Energy Restoration Systems, or KERS can be utilised once it becomes popular among the automobile industry. Currently, KERS is only used in Formula One racing vehicles. Flywheel Energy Storage can also be used in the future. Currently, it is mainly used in satellites for propogation. In the Flywheel Energy Storage Systems, the rotors are accelerated at very high speeds and the energy is maintained in the system in the form of rotational energy. Also, regenerative braking systems can be used as a cheaper option for using dynamo to generate power when braking.

VI. SIGNIFICANCE AND CONCLUSION

At present, there is no instinctive, reasonably priced, and operational wheelchair propagation equipment on the international market. As aoutcome, physical wheelchair operators with hemiplegia frequentlypractice their foot to push and direct, which can be very energetic and painful. Our reasonably pricedexpedientdelivers a resolution for these operators of average to inferior socioeconomic position in India. In the long run, our produce could spread tooperators from everywhere the world. Through our project, we want to deliverfolks with hemiplegia a resource of autonomous movement and perhapsaid them in their therapyprocedure by permitting them to practice their solid foot and handwhereas giving them the selection ofretrievaldeterminedprogram in their feeblelimbthrough the usage of a control. Upcomingeffortcomprisesimproved patient and psychoanalystparticipation in futurerepetitions, investigatingcontrols to find one that is instinctive to practice and delivers for adequatesympathy in reply to motion, and refining the security and aesthetics of our general design.

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