Design of Braking System in Stair Climbing Wheel Chair for Disabled

Mr. B. Elamvazhudi[1] K. Saranraj[2] G. Saravanan[3]
[1]Assistant Professor [2,3]Student
[1,2,3]Department of Mechanical Engineering
[1,2,3]IFET College of Engineering, Tamil Nadu India

Abstract— The main goal of this smart staircase climbing wheelchair project is reduce the cost of powered wheelchair and also locomotion of staircase by using of middle class people. The population of people with increase disabilities has significantly during the previous century. As the data come from the National Health Interview Survey (NHIS), two distinct developments have contributed to the increasing generally predominance of disability.as well as rapid increase that is due to health deficiencies and accidents. More individual persons have problem to use a conventional wheelchair. A current clinical appraisal indicates that 9%-10% of patients who received power wheelchair training found it extremely difficult to use for their activities of daily life style .40% of patients found the maneuvering, directional and steering tasks difficult or impossible. Generally the physically challenged people and paralyzed patients do their daily activities on wheelchairs. The disabled persons are to face an more difficulties, when they have to locomotion of ascend or descend the staircase. For example, to enter or exit erections, that have no slopes, go up and down in erections that have no lifts or pedestrian bridges, in these state of affairs, several helpers are necessary to carry a disabled person and their wheelchair. This leads to a possibility of injury for both the disabled persons and the helpers. This project was aimed to enhance the quality of life provides for the disabled people by supporting the wheelchair to climbing the staircase. To reduce number of helpers to only one person and wheelchair. This system is used to control the locomotion of a manual operated wheelchair by means of joystick control system wheelchair depends on the motor control and drive system, which consists of arduino microcontroller and low speed DC stepper motor. The steel rod is penta shaped and each rod is equally inclined of 72°from each other. At the time of climbing, one wheel that is the idle wheel will be in contact with the ground and the another wheel will be in contact with the stair. The motion takes place only when we pull the wheel chair backwards towards the staircase. The main aim of our project is to provide stability to the person who travels in the wheel chair (i.e., a large support base and maintain the overall centre of gravity as low as possible) the designed stair-climbing system consisted of two 5-spokes wheels and the slot plates. The 5-spokes wheels were used for climbing the stairs. The slot plates were used for sliding the rear wheels of the wheelchair. The 5-spokes wheels were installed at the rear of the wheelchair and were driven by power from an electric motor. When climbing the stair, the rear wheels were slid to the front of the wheelchair. To move on the floor, the rear wheels were slid back to the rear of the wheelchair. From test results, the wheelchair with the stair-climbing system could ascend and descend the stairs with the maximum riser height of 200 mm. The maximum payload was 80 kg.

Key words: Stair Climbing Wheel Chair, Braking System in Stair Climbing Wheel Chair for Disabled

I. Introduction

Fig. 1: Diagram of Brake

Braking system will be used here to stop the wheel chair, while driving towards the stairs.

A. Title: Motion Study of a Wheelchair Prototypez for Disabled People

1) Author: Ionut Daniel Geonea, NicolaeDumitru, AlexandruMargine

Design solution proposed to be implemented uses two reduction gears motors and a mechanical transmission with chains. The motion controller developed uses PWM technology (pulse wave modulation). The wheelchair has the ability of forward – backward motion and steering. The design solution is developed in Solid Works, and it's implemented to a wheelchair prototype model. Wheelchair design and motion makes him suitable especially for indoor use. It is made a study of the wheelchair kinematics, first using a kinematic simulation in Adams. Are presented the wheelchair motion trajectory and kinematics parameters. The experimental prototype is tested with a motion analysis system based on ultra high speed video recording. The obtained results from simulation and experimentally tests, demonstrate the efficiency of wheelchair proposed solution.

B. Title: Evolution of Wheelchair. Q, A Stair-Climbing Wheelchair

1) Author: G. Quaglia, W.Franco, M. Nisi

Solution for a stair-climbing wheelchair that can climb single steps or entire staircase. This device was designed in order to ensure greater autonomy for people with reduced mobility` the main component of the wheelchair structure is a three wheel locomotion. Unit that allows obstacle climbing thanks to an epicycloidol transmission. The other characteristic element in a idle track that behaves like a Second footh hold giving static stability during stair-climbing. Another important feature concerned with this design is a reconfiguration mechanism that makes the wheelchair suitable both for stair-climbing and for moving on flat ground. This feature allows performances and overall dimensions comparable to traditional electric wheelchair.

C. Title: Research on Leg-Wheel Hybrid Stair-Climbing Robot, Zero Carrier

1) Author: Jianjun Yuan, Shigeo Hirose

A novel leg-wheel hybrid stair-climbing vehicle, "Zero Carrier", which consists of eight unified prismatic joint legs, four of which attached active wheels and other four attached passive casters. Zero Carriers can be designed lightweight, compact, powerful, together with its significant stability on stair climbing motion, since its mechanism is mostly concentrated in its eight simplified legs. We discuss the leg mechanism and control method of the first trial model, Zero Carrier I, and verify its performance based on the experiments of stair climbing and moving over obstacles performed by Zero Carrier I.

D. Title: wheelchair.q, a mechanical concept for a stair climbing wheelchair

1) Author: Giuseppe Quaglia, Walter Franco and Riccardo Oderio

Wheelchair.q, a concept fora stair climbing wheelchair able to move in structured and unstructured environment, to climb over obstacles and to go up and down stairs. The wheelchair passively changes its locomotion, from a rolling on wheels to a stepping on legs one. The different locomotions are triggered only by local and dynamic conditions and not by an external command and so only one motor for each locomotion unit is necessary.

II. PROPOSED METHODOLOGY

A. Methodology

The prototype of a stair-climbing system was designed to attach to general unfoldable wheelchairs. This concept had an advantage since it was more convenient than creating a customized wheelchair. In addition, it could be applied to braking system of wheelchairs. A wheelchair used in this study before attached with a stair-climbing system. A spoke wheel was selected for climbing the stair because it was lighter and easier to maintain than a caterpillar track. The spoke wheel was designed to climb the stair that had the maximum riser height of 200 mm and minimum tread depth of 220 mm.

Fig. 2: Braking system

B. Characteristics

Brakes are often described according to several characteristics including

– Peak force – The peak force is the maximum decelerating effect that can be obtained. The peak force is often greater than the traction limit of the tires, in which case the brake can cause a wheel skid.
– Continuous power dissipation – Brakes typically get hot in use, and fail when the temperature gets too high. The greatest amount of power (energy per unit time) that can be dissipated through the brake without failure is the continuous power dissipation. Continuous power dissipation often depends on e.g., the temperature and speed of ambient cooling air.
– Fade – As a brake heats, it may become less effective, called brake fade. Some designs are inherently prone to fade, while other designs are relatively immune. Further, use considerations, such as cooling, often have a big effect on fade.
– Smoothness – A brake that is grabby, pulses, has chatter, or otherwise exerts varying brake force may lead to skids. For example, railroad wheels have little traction, and friction brakes without an anti-skid mechanism often lead to skids, which increases maintenance costs and leads to a "thump thump" feeling for riders inside.

C. Components

– DC motor
– Spokes
– Pulleys
– Power supply
– Brake
– Battery
– Battery charger

D. DC Motor

A DC motor is used to achieve precise positioning via digital control. The motor operates by accurately synchronizing with the pulse signal output from the controller to the driver. DC motors, with their ability to produce high torque at a low speed while minimizing vibration, are ideal for applications requiring quick positioning over a short distance.Oriental Motor offers a wide range of DCmotor products.

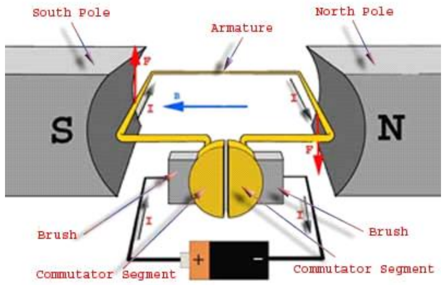


Fig. 3: Dc motor

Almost every mechanical movement that we see around us is accomplished by electric motor. Electric machines are a means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motors are used to power hundreds of devices we use in everyday life. Motors come in various sizes. Huge motors that can take loads of 1000's of Horsepower are typically used in the industry. Some examples of large motor applications include elevators, electric trains, hoists, and heavy metal rolling mills. Examples of small motor applications include motors used in automobiles, robots, hand power tools and food blenders. Micro-machines are electric machines with parts the size of red blood cells, and find many applications in medicine.

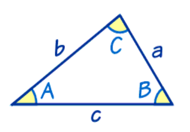
III. DESIGN CALCULATION

A. Law of Sines

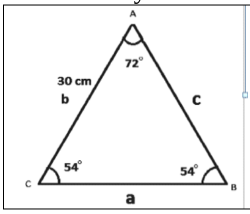
Trigonometry of triangles. The law of sines provides a formula that relates the sides with the angles of a triangle. This formula allows you to relatively easily find the side length or the angle of any triangle.

The Law of Sines (or Sine Rule) is very useful for solving triangles:

asin A = bsin B = csin C

	a, b and c are sides. A, B and C are angles. (Side a faces angle A, side b faces angle B and side c faces angle C).

When we divide side a by the sine of angle A it is equal to side b divided by the sine of angle B, and also equal to side c divided by the sine of angle C

	asin A = 8sin(72°) = 80.885... = 9.04... bsin B = 8sin(54°) = 50.552... = 9.06... csin C = 8sin(54°) = 90.995... = 9.05...

B. Dimensions of the Chair

- Frame dimensions at base = 38 * 38 cm
- Frame dimensions at back = 38 *38 cm
- Length of the handle for moving the wheelchair = 15 cm
- Length of hand rest = 23 cm
- Total height of the wheelchair = 77 cm
- Width of the wheelchair = 61 cm
- Height of the legs = 46 cm
- Radius of the spokes = 31 cm
- Diameter of the wheels = 9.5 cm
- Average height of the steps = 13 cm

C. Calculation for Rolling Resistance

Coefficient of rolling resistance [C_{rr}] = (0.0048) (18/D)(1/2) (100/W)(1/4)

Where,

D = Diameter of the rolling wheel in inches

W = Load acting normal to the wheel chairin lbs.

Rolling Resistance [F] = (W.C_{rr})/R The diameter of the wheel = 9.5 cm = 3.74 in

The maximum load acting normal to the wheel chair = 85 kg = 187 lbs.

C_{rr}= (0.0048) $(18/D)^{(1/2)}(100/W)^{(1/4)}$

C_{rr}= (0.0048) $(18/3.74)^{(1/2)}(100/187)^{(1/4)}$

C_{rr}= 0.009

F = (187*0.009)/1.87

F = 0.89 lbs

F = 0.404 kg

F = 4.04 N

D. Force Calculation

Force = mass*acceleration due to gravity =85*9.81 =833.85N

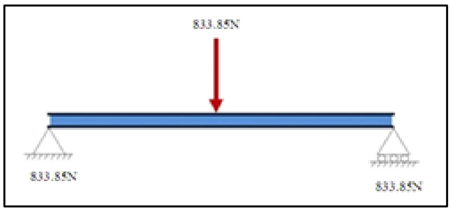


Fig. 4: Force

E. Torque Calculation

Torque =force*radius =833.85*4.75 =3960.7875N-cm

IV. HARDWARE PERIPHERALS

A. Rim Brakes

Rim brakes are so called because braking force is applied by friction pads to the rim of the rotating wheel, thus slowing it and the wheelchair. Brake pads can be made of leather, rubber or cork and are often mounted in metal "shoe". Rim brakes are typically actuated by the rider squeezing a lever mounted on the handlebar.

1) Advantages of Rim Brakes

Fig. 5: Rim brakes

Aluminium worn-out by V-brakes. Outer wall worn through and the wheel dangerously weakened.

2) Disadvantage of Rim Brakes

- Rim brakes are inexpensive, light, mechanically simple, easy to maintain, and powerful. However, they perform relatively poorly when the rims are wet.
- This problem is less serious with rims made of aluminium than on those with carbon fibre, steel or chromed rims.
- Rim brakes require regular maintenance. Brake pads wear down and have to be replaced. And before they wear out completely, their position may need to be adjusted as they wear:
- Rim brakes also heat the rim because the brake functions by converting kinectic energy into thermal energy.
- Although rim brakes are being superseded by disc brakes on off-road machines, rims with a hard, rough ceramic coating on the braking surface are available.

B. Spokes Wheel Design

Fig. 6: Spokes Wheel Design

C. Total Design Setup

Fig. 7: Total Design Setup

V. CONCLUSION & FUTURE WORK

This project resulted into a successful prototype of an Electro mechanical wheelchair, which has less cost. This minimized expense is pretty affordable for most of the people and it can be even cheaper when taken for mass production. This project can also be counted as a brilliant initiative for the betterment of physically handicapped and disabled people's lifestyle.

- Make a prototype and perform experimental test on it. Then find new parts which need to be modified and improve.
- Go up and down stairs without assistance .Develop the intelligent control making it more automated.
- Sensor detection and alarm system can be installed, which is used to notify the user when the wheel chair comes across obstacles.
- Using sensor to control the adjusting angle for the seat and backrest adjusting system instead of manual control.

Fig. 8: Photograph

REFERENCES

[1] Gurpude R., Design, Synthesis & Simulation Of Four Bar Mechanism For Guiding Wheel For Climbing, International Journal of Engineering Research and Applications, 2012.

[2] Hassan Abdulkadir, Design and Fabrication of a Motorized Prototype Tricycle for the Disable Persons, IOSR Journal of Engineering, May 2012, Vol. 2(5), pp.1071-1074.

[3] Modak G. S., Review Article: Evolution of a Stair-Climbing Power Wheelchair, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), pp. 36-41, 2009.

[4] Rajasekar R., Design and fabrication of staircase climbing wheelchair, Int. J. Mech. Eng. & Rob. Res., 2013.

[5] Salmin H., Design and Implementation of an Electric Wheelchair to economize it with respect to Bangladesh, International Journal of Multidisciplinary Sciences and Eng. 2014.

[6] Suyang Yu, Ting Wang, Xiaofan Li, Chen Yao, Zhong Wang and Di Zhi, 2010, "Configuration and Tip-Over Stability Analysis for Stair-Climbing of a New-Style Wheelchair Robot", International Conference on Mechatronics and Automation, Xi'an, China, pp. 1387-1392.

[7] Morales R., Feliu V., González A. and Pintado P., 2006, "Coordinated Motion of a New Staircase Climbing Wheelchair with Increased Passenger Comfort", International Conference on Robotics and Automation, Orlando, Florida, pp. 3995-4001.

[8] Sugahara Y., Yonezawa N. and Kosuge K., 2010, "A Novel Stair-Climbing Wheelchair with Transformable Wheeled Four-Bar Linkages", International Conference on Intelligent Robots and Systems, Taipei, Taiwan, pp. 3333-3339.

[9] Murray J. Lawn, Ishimatsu T., 2003, "Modeling of a stair-climbing wheelchair mechanism with high single-step capability", Transactions on neural systems and rehabilitation engineering, 11(3), pp. 323-332.

[10] Yuan J. and Hirose S., 2004, "Research on leg-wheel hybrid stair-climbing robot, Zero Carrier", International Conference on Robotics and Biomimetics, Shenyang, China, pp. 654-659.

