

Literature Review on An Optimization Design, Analysis of Stair-Climbing Planetary Wheelchair

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Abstract—One of the basic problems of a user on a manual wheelchair is overcoming hurdles on its way. A wheelchair is designed and examined with a planetary gear system attachment for the wheels. Advanced wheelchairs that are available in the market are expensive, i.e., around 10 hundred thousand rupees. This paper directs and proposes a methodology wherein it helps the disabled and older people to climb stairs. The structure and the assembly of a planetary wheel system's basic parameters required have been calculated for climbing steps without slipping. So in this paper, a cost-effective wheel-chair is designed which can be made available for the masses.

Keywords—*Stair-climbing wheelchair, Star Wheel mechanism, Solidworks modeling, Optimisation design.*

I. INTRODUCTION

Day to day the number of patients with disabilities is increasing, nearly 15% of the world population are disabled according to "the globally disabled report". Census 2001 has unconcealed that over twenty-one million folks in India are suffering from one or the other kind of disability, in movement (27.9%) is observed. A civilized society must guarantee fair living conditions for all its members, as well as disabled individuals. Stair-climbing wheelchairs play a vital role within the lifetime of disabled individuals. Mobility is the most typical drawback for disabled folks, a problem that the introduction of power wheelchairs has done much to alleviate. However, a power wheelchair is useless when confronted with obstacles. For this reason, several wheelchairs with stair climbing abilities have been developed. The invention of the chair is one of all the contributions for such physically challenged folks. It is a boon for them. Since the day the wheelchair was originated, it has been continuously improving its comfort level and with as many features as possible. We have come across many types of wheelchairs with totally different shapes, sizes, mechanisms, sources, materials, etc. After the design of the planetary wheelchair, the proper selection of material is done, which shows that the wheelchair is incredibly emphatic in terms of cost. Therefore, to solve the above problems and provide the superior performance of the means of transport for the elderly and the disabled people,

designing an inexpensive device for smooth and safe climbing stairs is of great significance and practical value. It not solely has got to resolve the inconvenience caused by the stairs in their lives however additionally considers users' affordability. In this project, we designed a stair-climbing wheelchair that features a compact structure, which will address flat or inclined tracks, stairs, and obstacles. All parts of the wheelchair were modeled in software Solidworks, then simulation analysis to make sure the strength of the framework, gear shaft as well as folding desk. We wish that this work will become a contribution to society serving a large quantity of disabled. Keeping all the on top of things in mind, focusing on the doable enhancements in wheelchairs, we got an idea of a stair-climbing wheelchair.

II. THEORY

After conducting an associate degree intensive literature review, it had been found that chairs with step ascent capacities will be categorized into 3 types: continuous stair-climbing wheelchair, intermittent stair-climbing chair, auxiliary stair-climbing chair. and therefore the continuous stair-climbing chair will be separated into 2 different kinds: planetary wheel mechanism stair-climbing chair and tracked wheel mechanism stair-climbing wheelchair.

A. CONTINUOUS STAIR CLIMBING WHEELCHAIR

The main property of the continual stair-climbing chair is that it solely has one set of supporting devices, the chair depends on this supporting device to comprehend continuous motions. in line with the motion causative mechanism, support ascension wheelchairs may be divided into a pair of categories; planetary wheel mechanism and caterpillar-tracked mechanism, and also the caterpillar-tracked mechanism is a lot of wide utilized in stair-climbing anti-riot robots.

B. Intermittent Stair Climbing Wheelchair

This type of chair has 2 supporting devices, that as an alternative work to complete the operation of ascension. Intermittent support ascension wheelchairs area unit one amongst the oldest kinds of support ascension wheelchairs. The operation of the ascension mechanism is: one amongst the support devices elevates the chair and also the alternative set

of webs first; then amendment to the opposite set of supporting devices to support and take back the front of the support device, cycle as this till finished ascension all the steps. This sort of chair has low transmission potency and problems keeping balance.

C. Auxiliary Stair Climbing Wheelchair

Another style of support-climbing chair is auxiliary stair ascension chair; it depends on the auxiliary device serving to attain the operation of ascension stairs, like the support-climbing chair attachments. The stair-climbing chair attachments admit another device put in on the chair, associate degreed it wants an assistant to assist to comprehend the operation of ascension supports; the stair elevator needs wide stairways if to put in the elevator that is extremely pricey.

III. LITERATURE REVIEW

A. Balance Control on the Development of Electric Wheelchair Prototype with Standing and Stair Climbing Ability with Tracked-Wheel Mechanism

This paper focuses more on the balance system on features of climbing stairs. The main object of this paper is to create a balance control system on the user's seat on climbing stairs and to keep wheelchair users on climbing stairs that are implemented on a standing and climbing wheelchair with tracked-wheel mechanism, COG setting is also necessary so as not to make the user fall and hurt. It has been found that the criteria of the stairs that must meet the needs of a wheelchair to be able to climb stairs such as dimensions of height of the stairs is not more than 20 cm and the slope of the stair is not more than 30 degrees. The balance system using PID control has a good response indicated by an error value of not more than 4 degrees. However, the balance control response occurs so slowly due to the use of linear actuators using a threaded mechanism that has a slow movement.

B. Design and Analysis of a Stair Climbing Wheelchair

This paper aims to bring forward a new means to climb stairs easily for older and disabled people. A stair climbing wheelchair machine is a semi-automated vehicle, which has the capability to climb the stairs easily. a wheel chair is designed and analyzed with planetary gear system attachment with the wheels. The structure and assembly of the planetary wheel basic parameters required have been calculated for climbing the steps without slipping. The stress analysis on the wheel chair has been done for its various operating conditions. When the wheelchair is climbing the stairs, there is always a danger of falling down the stairs, hence in order to protect the user to avoid this kind of situation from happening a ratchet mechanism locking system was proposed. In order to overcome this problem of falling, a seat backrest adjusting device was proposed for this wheelchair, so before the wheelchair climbs up and down stairs this device will adjust its angle for the seat and backrest to make certain the seat of the wheelchair keeps the level with the ground all the time..

C. Locomotion Solution for Stair Climbing Wheelchair with ER Fluid Based Control

In this paper a constructive new solution that allows the stairs to travel in normal rhythm is presented, without vertical balancing, the displacement being made is approximate linear trajectories. The taken solution is based on a variable geometry wheel and having a geometric control element, a stop valve with electrorheological fluid. The solution can only be applied to electric wheelchairs. When an uneven terrain occurs, it is determined if it is uneven below the height of a step of staircase. In this case, the wheels change their geometry by increasing their diameter and raising the centre of rotation of the wheel. After this, the wheel geometry is controlled so that the centre of the wheel has a linear trajectory. After completing a rough terrain area, it returns to normal movement. The travel solution for the wheelchairs will present a completely new solution to the stair climbing problem. This solution had superior performance in terms of the climb speed. It can also be easily adapted to existing electric wheelchairs on the market. There is no significant increase in the mobile mass of wheelchairs. Stair climbing is done automatically without requiring manual control or any adjustment of the process, which is a major improvement.

D. Motion Planning of Novel Stair-Climbing Wheelchair for Elderly and Disabled People

A new novel track-based stair-climbing wheelchair design which will improve stability and performance. The research paper takes into the account of wheelchair design, wheelchair speed control, controller design, etc with simulation results and actual calculations. There are two main parts in this mechanical design which are the chassis design and rubber tracks. In this design, there are three sets of arms called front arm, middle arm and rear arm; a total of six rubber tracks are used for this system. Also, for all arms there are three electromechanical linear actuators which are placed in between arms and chassis. The new track-based wheelchair design that was presented in this paper has been simulated, and experimentally tested for stability and performance. It has been verified that the motion of the user along the staircase is free of sudden variations. Wheelchair was tested in descending and ascending operations with unique motion planning algorithms in the two modes

E. Synthesis, Modeling, Analysis and Simulation of Stair Climbing Mechanism

This paper reveals synthesis, modeling and simulation of mechanism for guiding wheels for climbing mechanism. A self-propelled wheelchair which is adaptable to climbing and descending stairs and slopes. Operation on normal ground is similar to the operation of a conventional wheelchair. Propulsion power for both conventional level operation and the stair climbing operation is transmitted through the motor and hand wheels. The front wheels are star wheels which take power from the crank with the help of a motor and are mainly used for climbing the stairs. New chair with three mechanisms like, star wheel and a simple driving mechanism will help to prepare a chair that will be able to

climb without anyone's assistance or with assistance. This chair will be helpful to climb a stair with a particular height and width.

IV. PROBLEMS FACED BY EXISTING MODELS

There are numerous problems faced by different-different types of wheelchair which are:

A. Tracked stair climbing wheelchair

- 1) Heavy
- 2) Noise
- 3) Low efficiency
- 4) Destroy the stair

B. Auxiliary Stair Climbing Wheelchair

- 1) Need auxiliary device
- 2) Need an assist
- 3) Expensive

C. Leg stair climbing wheelchair

- 1) Low automation
- 2) Unable to maintain level
- 3) Complex controls
- 4) Slow movement and low carrying capacity

V. PROPOSED METHODOLOGY

The pros and cons of different types of wheelchairs are compared and abridged, in sequence to make our design overcome those cons. Planetary wheel mechanism has a great advantage among the stair-climbing wheelchairs, which not only has a simple and compact structure, flexible movement, good stability, small fluctuation range of gravity centre, but also combines the advantages of moving on the ground and climbing stairs with assistance. Therefore the planetary wheel mechanism is chosen as the walking mechanism in our design. The planetary wheels mechanism is optimized to extend the life of the gear for the transmission system and improve the security of the wheelchair. Locking system is attached which is used to lock the wheelchair while climbing up and down the stairs, confirming it can only move in one direction, and safeguard the wheelchair from slipping down. And collaborating the principle of user-friendly: a desk, shopping basket is added. Then all parts of the wheelchair are modelled in Solidworks and the strength of the important components of the wheelchair will be analyzed.

VI. RESULTS AND CONCLUSION

Design the walking mechanism, transmission system for our stair-climbing wheelchair and according to the calculations of our design which actually decides the structure of the wheelchair and then model all the parts of the wheelchair.

- 1) Three different kinds of materials have been chosen to analyse in Solidworks, in order to realize optimization selection.

- 2) Strength checking on the locking system and the desk in Solidworks to make sure the safety of the wheelchair is good.
- 3) The optimization of ergonomics has been added in our design to make the wheelchair more convenient and comfortable.
- 4) Lock system is added to avoid the wheelchair slipping down while climbing up and down stairs.

VII. FUTURE SCOPE

- 1) Go up and down stairs without assistance.
- 2) Make a prototype and perform experimental tests on it. Then find new parts which need to be modified and improved.
- 3) Develop intelligent control making it more automated.
- 4) Belts can be added to protect the user.

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