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DESIGN AND MANUFACTURING OF AUTOMATED STAIRCASE CLIMBING WHEELCHAIR PROTOTYPE BY USING BELT DRIVE

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ABSTRACT

A self-propelled battery-powered wheelchair replaces an ordinary wheelchair and provides improved access to homes. The wheelchair includes stair climbing, slope climbing, and reclining while requiring only minimal driver skill and strength. Operation on level ground is similar to the operation of a conventional wheelchair. Drive is given by motors to the rollers and belt assembly. This will make the task of climbing the staircase is easy for handicapped person. For that we have design a manually operated wheelchair that can travel on both plane terrains and also in staircase. The motion takes place only when we pull the wheelchair the forward to the staircase. The main aim of our project is to provide stability to the person who travel in the wheelchair also the main aim of our projects is to afford this wheelchair stair climbing facility for middle class people, handicapped people.

Keywords: Stair climbing, low cost, low weight, easy to handle.

I.INTRODUCTION

Since the beginning of mankind, he has been improving himself in science and technology. This is to overcome his difficulties and reach & improvise his comfort levels.

It's not that every man is born perfect some have their own difficulties, problems and disabilities. Some are since their birth and some by the game of time. They struggle a lot to lead life in the society. Wheelchair is one of the most commonly used assistive devices for enhancing personal mobility, which is a precondition for enjoying human rights and living in dignity and assists people with disabilities to become more productive members of their communities.

The invention of wheelchair is one of the contributions for such physically challenged people. It is a boon for them. Since from the day wheelchair was invented, it has been continuously improving to raise its comfort level and with as many features as possible. We have come across many types of wheelchairs with different shapes,

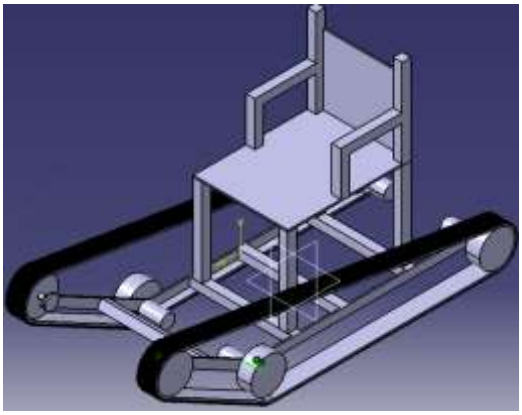
sizes, mechanisms, sources, materials etc. For many people, an appropriate, well-designed and well-fitted wheelchair can be the first step towards inclusion and participation in society.

A special type of wheel chair is designed which can be used to ride on stairs**.** So many works were done on automated wheelchair. But this factor was not considered or solved before in the way which would be discussed later. Emphasis was given on solving the problem as well as other facilities provided before. Giving ease to user in different postures is another important purpose**.** The design presented in this paper will provide more physical and psychological advantages to the user because of scientific approaches and creativities. Our design will provide complete automatic control and higher mechanical efficiency. The most important thing is that, we included new scientific criteria (found by our analysis and experiment) that would provide the facility to ride on stairs that was not provided before. Obstacles in free movement are a curse to a human life. The wheel chairs available in the market provide them little facilities but it needs a lot of manual work done by users or helper to be operated. Its' movement area is limited also. This limitation creates a mental stress on a handicap specially those who are handicaps by accident**.** These phenomena added fuel to fire in this thinking and this is why a highly efficient wheel chair is presented.

1. ***What is new in the wheelchair.***

The wheelchair is capable of climbing the stairs. However, this concept is already worked out, but it works either with the need of a helper or using electrical power and batteries. Our project aims at climbing stairs mechanically and self-operated, not depending on someone. Simplification is done in both operation and construction. Our project aims at reduction in the overall cost of the stair climbing wheelchair are isolated and do not have access to the same opportunities as others within their own communities. Providing wheelchairs that are fit for the purpose not only enhances mobility but begins a process of opening up a world of education, work and social life.

II.METHODOLOGY



- ***Market Study***

The methodology for this project began with market study of the product under consideration. This involved extensive evaluation of the various types of wheelchairs available in the market and a precise overview of the Indian market scenario.

- ***Electric Wheelchair***

  The foremost electric wheelchair was invented by George Klein with the purpose to help the wounded soldiers of the World War II. With time, it has evolved into many designs and forms. The power chairs comprise a range of functions like reclining, tilting, seat elevation, chin controller, hand controller and many more. Some of the models are portable that is they can be disassembled and carried along while travelling. The electric wheelchair is characteristically categorized into three categories

- The front wheel powered chair: It is a power chair for indoor purposes. This is a four wheel driven chair and is most flexible among the lot.
- The rear wheel powered chair: It is a power chair facilitated for outdoors. Being rear wheeled, they are appropriate for rugged roads.
- Mid wheel powered chair: This electric wheelchair is apposite for indoors but it has sturdy steering functions.

III.WHEELCHAIR AND STAIR CLIMBING FRAME

The problems associated with the above two concepts was revolved by integrating the concepts and giving rise to a new idea of providing a stair climbing frame on a conventional wheelchair. A conceptual representation of flexible wheelchair design that can shift from conventional wheelchair position to stairs climbing position.

The convertible wheelchair design can help users to access flat surface as well as stairs in a convenient way. The concept was further refined by considering the technical parameters like weight, effort and comfort ability. The below critical parameters were analyzed and taken care during the prototype development stage. The lever arm should be designed with an effective gear system to reduce the efforts and enhance the efficiency of the wheelchair.

- A provision of resting in the midway while ascending or descending is important, as the users may get tried in the climbing process.
- The size and range of steps in building staircase.
- Designing a convenient transition between conventional wheelchair to a stairs climbing position and vise versa.

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IV.MATERIAL SELECTION

There are two principles that should be followed, when selecting material and analyzing if the selected materials based will meet the strength requirements. The two principles are choosing materials based on strength theory and choosing materials based on stiffness theory, which will be introduced in the principles choosing of material. And other factors such as comfort, environmental friendliness and so on should also be considered. Considering the situation of our design, the primary stress act on the frame is tension so principle one based on strength theory is applied to choose our material.

Where FN=FP, FP is the pulling force which has been calculated. At present manufactures usually choose aluminium alloy or alloy steel as wheelchair materials and both of these two materials can meet the above strength requirements, so simulation analysis in the chapter of simulation and analysis will analyze which material has better properties.

V.CALCULATIONS

- ***Model calculation***

Consider, design for 25kg

Acceleration of gravity = 9.81m/s^2

$$F = W \times g$$

$$= 25 \times 9.81$$

$$= 245.25N \approx 250N$$

d = diameter of roller, 100mm

$$T = F \times \frac{d}{2}$$

$$= 250 \times \frac{100}{2}$$

$$= 12500Nmm = 12.5m$$

μ = friction, 0.25

$$T = 12.5 \times 0.25$$

$$= 3.125Nm$$

- ***Motor calculation***

P = Power, in W

$P = F \times \frac{d}{t}$ Assume, $\frac{d}{t} = 60\text{mm/sec}$

$= 250 \times 0.060$

= 15W.

Now the efficiency of motor is 80%

$P = 15 \div 0.8$

= 18.15W = 0.01875KW

N = Speed, in rpm

$P = \frac{2\pi NT}{60 \times 1000}$

$N = \frac{0.01875 \times 60 \times 1000}{2\pi \times 3.125}$

N = 57.29 RPM

From above calculation we purchase motor

Available motor = 50RPM

And Torque = 3.5Nm

Respectively we use 4 motors in model

VI.CONCLUSION

- Design the walking mechanism and transmission system for our stair-climbing wheelchair, according to the calculations which decide the structure of the wheelchair, then model all parts of the wheelchair.
- The optimization for the planetary wheel system changes the torsion acting on the box of the gear train instead of acing on the gear, which protect the security and service life of the gear.
- The optimization of ergonomics has been added in our design to make the wheelchair more convenient and comfortable.
- Two different kinds of materials have been chosen to analyse in Autodesk Inventor, in order to realize optimization selection.

- Assembling simulation is carried out in Creo in order to avoid interference between different parts of the wheelchair. We consider that there are some improvements that need to be done in the future, for example:
- Here we used AC supply to run the motors but in future we can also use battery for this purpose.
- Users can adjust the seat backrest system to make sure the seat of the wheelchair is parallel to the level ground when it climbs up and down stairs.
- Lock system can be added to avoid the wheelchair slip down while climbing up and down stairs.

VII.FUTURE SCOPE

- Light materials can be used to reduce the weight of the system.
- Emergency call system can be added.
- Further electronic devices can be added like tablet, heated seat, etc. which can be counted as accessories.

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