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DESIGN OF STAIR CLIMBING WHEELCHAIR

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Abstract - *In this thesis, the design and analysis of an affordable automatic step climbing wheel-chair for physically disabled is presented. The motivation is to cater the needs of disabled people who are at economically disadvantage position. Global statistics of the disabled persons report shows that the number of disabled people is increasing with the increase in world population. It may be noted that the electrically operating lifts are not common in two or three storey buildings. Therefore, step climbing wheel-chair can make life easy for disabled people in terms of accessing any location in a building without help of others. Advanced wheel-chairs that are available in the market are having high cost, i.e., approximately ten lakh rupees. So in this thesis a cost effective automatic wheel-chair is designed which can be made available for the masses. It helps physically disabled and elderly people to move across stair cases easily.*

Key Words: Stair-climbing Wheelchair, Catia Modeling.

1. INTRODUCTION

Day to day the patients with disabilities go on increasing, nearly 15% of the world population are disabled according to "the globally disabled report". The physically disabled people have less living space and the life is seriously affected and faces difficulty problems with their family. Stair-climbing wheelchair plays an important role in the life of disabled people. The society nowadays concentrating on physical disabled and old people developing and constructing elevators, but it is not possible everywhere we go. The disabled people feel difficult to travel from one place to another due to inconvenient for them by using an ordinary wheelchair even though they have help from others. So most of the times the physically disabled people will remain in homes due to lack of facilities like elevators and uneven roads. Due to the above activities, it may influence their physiology and psychology.

Limb disability is one of the disabilities which are caused due to various reasons such as deformation by birth, war, disorders such as diabetes. Lower limb of sports person also suffers huge blows while playing and are always at the risk of suffering severe injuries. These injures sometimes may be a permanent disability.

The invention of wheelchair is one of the contributions for such physically challenged people. It is a boon for them. Since from the day chair was fabricated, it has been continuously improving to raise its comfort level and with as many features as possible. We have come upon many sorts of wheelchairs with completely different shapes, sizes, mechanisms, sources, materials etc. For many individuals, associate acceptable, well-designed and well fitted chair may be the primary step towards inclusion and participation in society.

Though the wheelchair is helping the physically challenged & disabled people for their mobility, it is not equivalent to the motion by normal people. They can't run, jump and reach all places where ever they wish to go. These suppress the mental level of these individuals and that they begin feeling themselves as „burden" to others. To overcome this psychological depression, the comfort level ought to be raised up to the „peak", where they can do all those things that a normal man can do. This is the responsibility of the engineers. We have the responsibility of satisfying the needs of people. When the need is not met, people with disabilities are isolated and do not have access to the same opportunities as others within their own communities. Providing wheelchairs that are fit I'm not solely enhances quality however begins a method of gap up a world of education, work and social life. So this can be our tiny step or plan to reach that „peak". We want that this work can become a contribution for the society serving to sizable amount of disabled. Keeping all the on top of things in mind, focusing the doable enhancements in wheelchairs, we got an idea of a stair climbing wheelchair.

2. LITERATURE REVIEW

After conducting an intensive literature review, it was found that wheelchairs with stair climbing capacities can be categorized into two types; the battery powered and the manual powered. Although there are plenty of powered wheelchairs available in the market place, there are limited scholarly reviews published on manual or battery powered wheelchairs. Instead, patent certificates, wheelchair descriptions, and operation manuals are available. Indeed, no peer reviewed literature was found for manual wheelchairs. Some researchers have built scale models or full size prototypes of their designs but little documentation has been published on this type of wheelchairs.

In 1962, Ernesto Blanco, while working at Massachusetts Institute of Technology (MIT), designed a self-propelled stair-climbing wheelchair, but a full scale prototype was never built. However, a small model of Blanco's design was built to showcase how his wheelchair would perform rolling in flat ground as well as how it would climb and descend

stairs. Although no peer reviewed literature was published on Blanco's wheelchair, the mechanism can be examined from the description given in MIT's website and picture of the model.

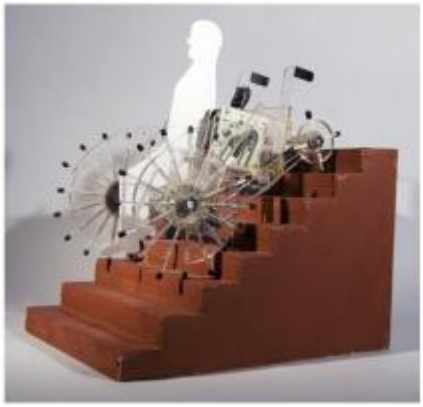

Figure 1: Ernesto Blanco's Wheelchair Climbing a Staircase

The spokes that extend outward away from the drive wheels are loaded with springs. The spokes are spaced in such a way that, as the wheelchair rolls on flat terrain; they are completely compressed inward, allowing the wheelchair to roll entirely on its drive wheels. While climbing or descending a staircase, the spokes project outward away from the drive wheels to engage the top edges of the steps.

The contact points act as pivot points and allow the user to climb or descend softly. As the drive wheels roll on top of the spokes, these are compressed inward allowing the drive wheels to rest on the top flat surface of the step. Not much else can accurately be said of Blanco's wheelchair as no other literature was found.

A second manual stair-climbing wheelchair found through an internet search is Vardaan. Figure 2 is a wheelchair designed by a group of four engineering students at the Indian Institute of Technology (IIT). Vardaan is capable of climbing a wing of stairs by pulling on handle bars connected to sets of "Y" shaped wheels. The power arms are connected to ratchets and braking systems making a safe and stable climb and descend. As with the previous wheelchairs, there exists very little published documentation that further explains how Vardaan climbs. Lola Nayar describes the project and its innovative climbing procedure conducted by Shanu Sharma, and mentored by Prof. Kanpur. Currently, the wheelchair designed by Shanu Sharma has been approved by the IIT science and technology departments for further research and possible mass production.

Figure 2: Vardaan Manual Stair-Climbing Wheelchair

The wheel frame is designed to hold the tri -wheels comfortable on each side of the shaft. The wheel frame, first it is made of straight wheel frame and became more complicated while climbing so it is modified to quasi-planetary wheel frame to create more frictional force and provide smooth power transmission for climbing stairs. This quasi-planetary wheel frame is suitable to transmit exact velocity ratio. The wheel frame setup is designed to provide higher efficiency. The maintenance is less because of simple design parts and failure occurs in the bolt, washer, nuts, etc.

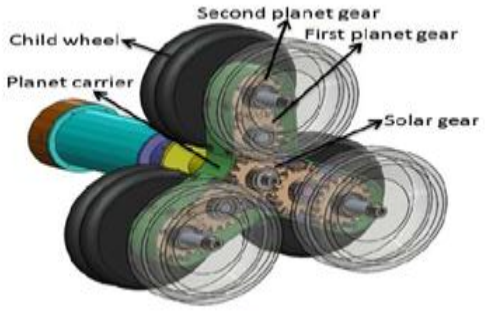

Figure 3: Tri wheel Mechanism

3. OBJECTIVES

(a). To design a stair-climbing wheelchair for differently-abled person with lower limb disability in order to increase their mobility

(b). Making the total prototype as cost-effective as less expensive as possible.

(c). It must be easy to understand, so that can be utilized effectively by masses absent a lot of information on its mechanical foundation.

4. CATIA MODEL

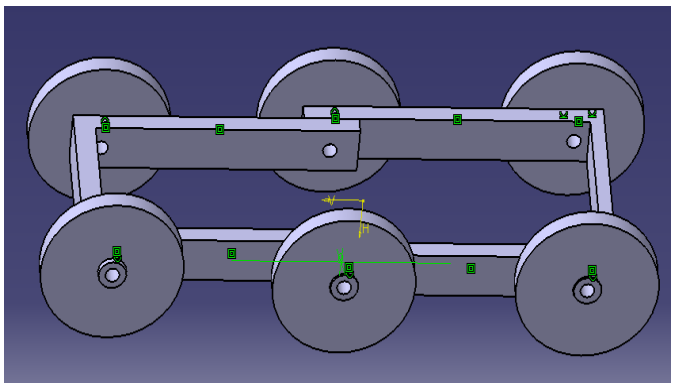

Figure 4: CATIA model of Base Frame of the Wheelchair

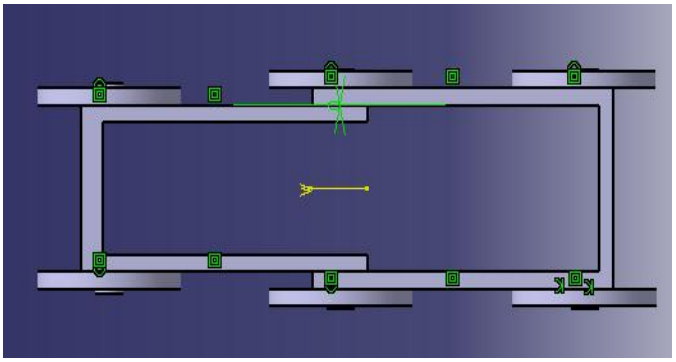

Figure 5: TOP View of the CATIA Model

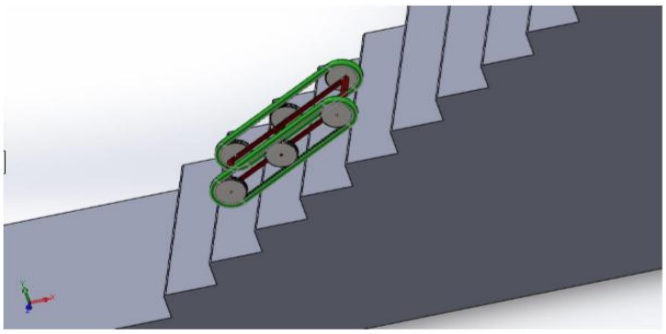

Figure 6: CAD model of the chassis of wheelchair.

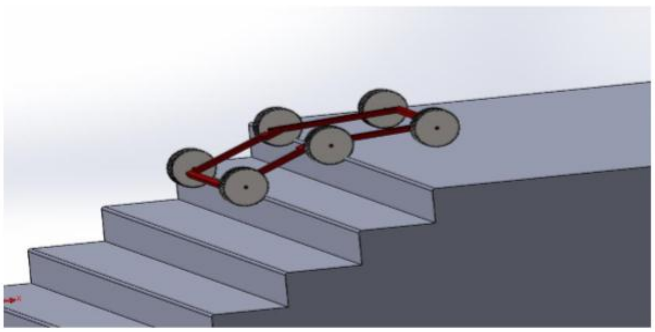

Figure 7: CAD model of wheelchair while landing.

5. TORQUE CALCULATION

Stair dimensions:

Land: 254.0 mm

Rise: 177.8 mm

Slope of stair (θ) = $\tan^{-1}$ (177.8/254) = 35^{o}

Torque required on a flat surface:

Normal force (F_n) = force applied = m*g

= 100*9.81

= 981N

Friction force (F_f) = F_n*μ

= 981*0.2

= 196.2 N

Torque required = F_f*r_w

= 196.2*0.18

= 35.316 N-m

According to the calculations done, the stair climbing wheelchair has a capacity of carrying a load of 100kgs on flat surface. It has the ability to ascend a flight of stairs of 35-degree elevation.

ADVANTAGES:

- The wheelchair can be used to climb up or climb down the stairs.
- The seat can be tilted to the required angle.
- The wheelchair can climb stairs up to 7 inches in rise.
- The operation of the wheelchair is easy.

DISADVANTAGES:

- The wheelchair is heavy.
- The width of the wheelchair is more than the usual wheelchairs.

6. CONCLUSIONS

The design of the wheelchair is compact and hence is able to move about in almost all the stairs that we find at institutions, offices, industries and also at some homes. The design is made very safe and there is no chance of failure of the frame and wheels under normal conditions

It can move on structured and unstructured planes and go up and down staircase. It can also climb over the obstacles with low jerk felt by the user. The use of rubber material for belt helps in damping the vibrations. The seat backrest adjustment system is designed ergonomically so that it keeps the passenger always parallel to the ground plane.

7. FUTURE SCOPE

- The wheelchair can be automated by using electronics so that it will automatically sense and climb the stairs.
- The wheelchair can be robotized by utilizing gadgets so it will consequently detect and climb the stairs

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10. BIOGRAPHIES

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