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Design And Fabrication Of Intelligent Wheel Chair

[1]Harishbabu.L, [2] Sahan. S, [3] Lakshmanan.N [4] Shivaraj. K [5] Mahesh. M, [6]Shankar. N
[1] Professor [2],[3],[4] [5] UG Scholars
Department of Mechanical Engineering
Sri Sai Ram College of Engineering, Anekal, Bengaluru

Abstract: **-- The project aims at designing a wheelchair capable of climbing staircases for physically handicapped people. The main conceptual elements that have been proposed to improve this idea are mainly to simplify the mechanism and make it work using minimum effort of human.In the field of providing mobility for the elderly or disabled the aspect of dealing with stairs continues largely unresolved. This project focuses on fabrication of the stair climber, a duel section tracked wheelchair capable of negotiating the large number of twisting and irregular stairs typically encountered by the residents living on the slopes. This wheelchair extends the capabilities of traditional powered devices by introducing control and navigational intelligence. These devices can ease the lives of many disabled people, particularly those with severe impairments, by increasing their range of mobility. A standardized autonomy management system that can be installed on readily available power chairs which have been well-engineered over the years has been developed and tested. A behaviour-based approach was used to establish sufficient on-board autonomy at minimal cost and material usage, while achieving high efficiency, sufficient safety, transparency in appearance, and extendibility. So far, the add-on system has been installed and tried on two common power wheelchair models. Initial results are highly encouraging**

***Keywords*- Stair Climbing, Intelligent, Epic Cyclic Gear System**

I. INTRODUCTION

The number of patients with disabilities is on the rise according to the firsts report", there are 650 million people which are about 10% of the global population are disabled in the 1970s, and now the number has increased to 15%. Aging population who have chronic diseases is rising which makes the proportion of disabled persons expand. The proportion change of elderly people and younger people from 1950 to 2050, the percent of the young children is decreasing from 13% to 6%, in contrast to the percent of elderly population which keep increasing sharply.The sick or disabled people among working age of 15 to 64 are 13.2% of the population in EU, and Sweden have the highest number which is 36.5%. Therefore the situation in Sweden is very serious and nursing care for the elderly and disabled people will become a big burden in the near future.The people with physical disability not only have less living space, but also the quality of life is seriously affected and it also brings big burden to their family. Wheelchair as a means of transport tool plays an important role in the life of those people who are old and disabled. With the society paying more attention to the benefits of elderly and disabled people, barrier free facilities as well as the elevator has been widely popularized, common wheelchairs can easily access many places, but when the user face stairs which often poses as obstacles, people can only step back, even though with the assistance from others, it is still very difficult to overcome these obstacles, which is inconvenient for those people who use wheelchairs. So most of the time these disabled or elderly people can only stay at home, and lack of activities outside may influence on their physiology and psychology.

BTH had a collaboration agreement with the government and the projects of recent years had been focused on making life easier for the disabled and elderly people. The previous students in BTH had already designed some wheelchairs toilet [4] Optimization design for the standard manual wheelchair [5] etc, but the device for helping people to go up and down stairs can be much 9 improved, therefore considering above factors this topic is chosen by our group. This thesis is based on the existed stair-climbing wheelchair; the advantages and disadvantages between different types of wheelchairs are compared and summarized, in order to make our design overcome those disadvantages. The planetary wheels mechanism is optimized to extend the life of the gear for the transmission system and improve the security of the wheelchair; the seat backrest adjustment system is added which is used to adjust the centre of gravity of the wheelchair and keep the seat always in level with the ground while climbing up and down stairs. This device can also prevent the wheelchair from overturning backward, and improve the security and comfort of the wheelchair. Locking system is added which is used to lock the wheelchair while climbing up and down stairs, making sure it can only move in one direction, and protect the wheelchair from slipping down. And combining the principle of ergonomics: a desk, shopping basket is added, and a curved seat is designed which makes the seat more comfortable and convenient. Then all parts of the wheelchair are modelled in Autodesk Inventor, and the strength of the important components of the wheelchair will be simulation analysed.

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II. BACKGROUND

The stair-climbing wheelchairs which exist at present can be grouped into three categories: continuous stair-climbing wheelchair, intermittent stair-climbing wheelchair, auxiliary stair-climbing wheelchair. And the continuous stair-climbing wheelchair can be separated into two different types which are: planetary wheel mechanism stair-climbing wheelchair and tracked mechanism stair-climbing wheelchair.

CONTINUOUS STAIR-CLIMBING WHEEL CHAIR

The main property of the continuous stair-climbing wheelchair is that it only has one set of supporting device, the wheelchair relies on this supporting device to realise continuous motions. According to the motion actuating mechanism it can be divided into planetary wheel mechanism and tracked mechanism, and the tracked mechanism is more mature which is used much widely in stair-climbing anti-riot robot.

PLANETARY WHEEL MECHANISM STAIR-CLIMBING WHEELCHAIR

The planetary wheel mechanism is constituted by several small wheels that are equally distributed Y .Wheels can revolve on its axis, and it can also make a revolution around the central shaft. Every small wheel revolves on its own axis, when the wheelchair moves on the ground; and every small wheel revolves round the central axis, when the wheelchair goes up or down stairs. This type of stair-climbing wheelchair can fulfil overloading and move smoothly but has low automation. The typical product of this kind of wheelchair is IBOT which is shown in figure 3.1. IBOT is developed by an independent technology company which is subsidiary of Johnson Company in the United States of
America. It took over 8 years of development, and cost more than 1.5 hundred millions, which performance tops the highest index among the currently existing stair-climbing wheelchairs. The structure of the IBOT is very compact, movement flexible and operation convenient, and the best optimization is that IBOT can stand up with two wheels. But it is very expensive, the price is $29000[6], which means lots of people cannot afford it.

TRACKED MECHANISM STAIR-CLIMBING WHEELCHAIR

At present stair-climbing wheelchair with tracked mechanism has beenwidely used which is shown in figure 3.2, and compare with the planetary wheel mechanism, tracked mechanism uses more continuous motion mode and has high transmission efficiency. The movement of the gravity centre of the tracked mechanism wheelchair is always along with a line which is parallel with the connection line of each stair edge when the wheelchair goes up and down stairs, and the wheelchair moves very smoothly, but the biggest weakness is that it has great resistance when it is moving on the ground, and inflexible; high pressure will be exerted on the edge of the stairs when tracked mechanism goes up and down stairs, so the stairs are easily damaged by the wheelchair.

INTERMITTENT STAIR-CLIMBING WHEELCHAIR

The main characteristic of intermittent stair-climbing wheelchair is that ithas two sets of supporting devices, which alternately support the wheelchair in order to realize the function of climbing stairs. The process of climbing stairs of this mechanism is similar to the people climbing up and down stairs, so it is also called walking stair-climbing wheelchair. Most of the early stair-climbing wheelchairs use this method, such as, the first stair-climbing wheelchair which was developed in 1892. The principle of intermittent stair-climbing wheelchair climbing stairs is: one of the support devices elevates the wheelchair and the other set of support system first; then change to the other set of supporting device to support and take back the front of the support device, cycle as this until finished climbing all the stairs. The principle figure is shown below and the process of climbing is not continuous. The main characteristic of the intermittent stair-climbing wheelchair is that has low transmission efficiency and difficulty keeping balance.

AUXILIARY STAIR-CLIMBING WHEELCHAIR

There is another stair-climbing wheelchair which relies on the other auxiliary device helping to achieve the function of climbing stairs, such as the stair-climbing wheelchair attachments and the stair lift in the below figures. The stair-climbing wheelchair attachments rely on another device install on the wheelchair, and it needs assistant to help to realise the function of climbing stairs; the stair lift requires wide stairways if to install the lift which is very expensive.

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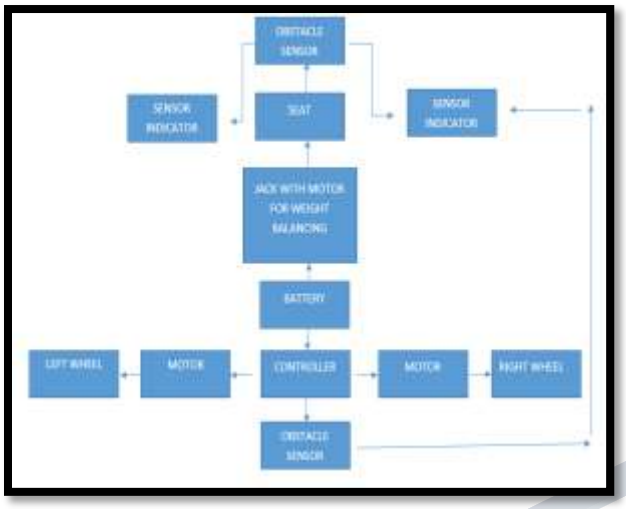
III. BLOCK DIAGRAM



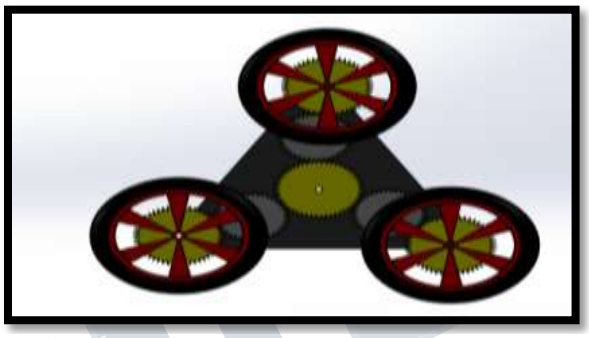
TRANSMISSION SYSTEM DESIGN

In this section the transmission system will be designed and the principleof the transmission mechanism will be considered first; then the gears inside of the planetary wheel system will be selected and assembled; the motors selection as well as the storage battery selection will determined later.

WORKING PRINCIPLE FOR THE TRANSMISSION SYSTEM

Wheelchair was designed to cope with flat, inclined ground, stairs and obstacles. An epicyclic gearing was chosen as the transmission system for each locomotion unit, where the two degrees of freedom are wheels and planet carrier rotations. If we want the wheelchair to have determined locomotion, we must give two determined inputs to every locomotion unit.

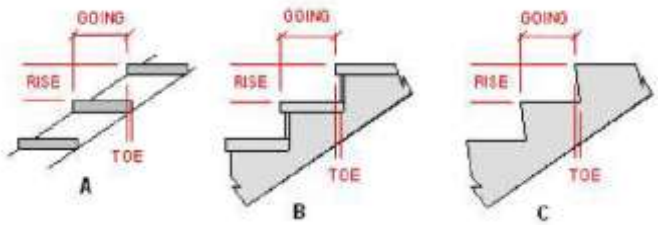
And the work principle for our stair-climbing wheelchair is: one inputcomes from one motors driver solar gears of the epicyclic wheels system refers to the figure, and the other degree of freedom is constrained by the situation of the ground. When the surface of the ground has low friction, planet carrier (i.e., the other input) can make the real-time adaptive adjustment according to the road conditions; when the wheelchair climbing stairs, one of the degrees of the freedom is restricted by the stairs, thewheels cluster can evolve into a planetary wheel system, the planet carrier drives the other two wheels around the wheel which degree of freedom is constrained to achieve the function of climbing stairs.



DETERMINATION OF THE BASIC PARAMETERS OF THE EPICYCLIC WHEELS SYSTEM

The range of the structure size of the planetary wheels system is determined by the staircase, and the wheels of the wheelchair needs a stable support on the stairs during the process of climbing stairs, if the diameter of the wheels are too large, the wheelchair is unable to support itself on the stairs, and it is also not good for reducing the volume of the wheelchair; if the diameter is too small, the wheelchair will have a low efficiency when it moves on the flat ground, and it has a poor ability to adapt to the terrain. The step-wide G and the step-height R are determined by the stair design rules, which is shown in the table.

RISER (R)		GOING (G)		SLOPE RELATIONSHIP = 2R+G	
MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM
190	115	355	240	700	550



DIFFERENT TYPES OF STAIRS

Apparently, the width of the staircases should be less than 240mm; the height should not be more than 190mm. The

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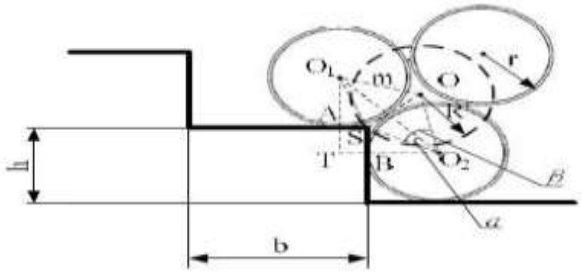
design of stair-climbing wheelchair should have stable support in the minimum width of 240mm,and can also roll in a certain distance. So here the width of the stairs
b=240mm, and the height h=140mm are chosen, as the calculation reference of our design.



Based on the geometrical relationship in the picture above, the following calculation is carried out

$SO_2 = \sqrt{BO_2^2 + BS_2^2} = \sqrt{r^2 + (h-r)^2}$
$O_1O_2 = 2m\cos 60° = \sqrt{3}m$

ADVANTAGES

- Stair Climbing Capacity
- Suitable to almost all chairs
- Compact
- Convenient Operation

DISADVANTAGES

- Manufacturing Cost is high
- Requires Assistance

CAD MODEL

IV. CONCLUSION

- This project will give new hope to the physically challenged and aged people.
- Our ultimate aim is to make it as product and donate to government for helping the society.
- Our systems will be easily accessible by the end users.

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