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### Abstract

Wheelchairs are used by people for whom walking is difficult or impossible to due to disability. In overall world population about 7.3% of people are disable. It creates number of problems for them overcoming various obstacles like Stairs etc. Conventional wheel chairs are not self operated, they are manually operated, as they face problems while climbing Stairs. A concept of stair climbing wheel chair capable of moving on flat road automatically, as well as Climbing Stairs with special geometry is briefly explained in this paper. Main goal is to provide information to reader how the technology and science can be used for betterment of society.

**Index Terms:** Wheelchair, Spider, shaft, gear, cradle mechanism etc.

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## 1. INTRODUCTION:

In day to day life man is been improving himself in fields of science and technology. This is to overcome his problems and improve comfort levels. Mobility is the most frequently problem faced by physically disabled people. 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 disable.

After the PWD act in 1995, number of building are developed keeping in mid disabilities of people though there are many building designed without considering mobility of physically challenged people. This provides a scope of development for disabled people.

On observing the few prototypes that have been made to serve similar purposes, we observed that the designs were very complicated and robust and thus could be optimized by modifying the mechanism and materials of components that was employed.

There are many attempts made since 20<sup>th</sup> century to reduce the human efforts by introducing a power wheelchair.

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Power wheelchairs are useless when they face obstacle like stairs. This gives another chance of development in areas of stair climbing wheelchairs for Engineers. Several attempts are made in developing stair climbing wheelchairs. Some of the wheelchairs uses tracks, which requires high energy resulting high power input and they are also robust in construction due to material used for chassis as well as components. Other solutions like iBot adopt hybrid locomotive systems, which is efficient. Major drawback of these iBots is, it's excessive cost to achieve safety standards.

## 2. WORKING PRINCIPLE:

### 2.1 Fabrication of Multi-purpose Wheelchair:

The power is generated using a DC geared motor. This motor is coupled with a gear box. Due to this the high speed, low torque input of the motor gets converted to low speed high torque output. The geared box is coupled with the center shaft which gets high torque but low rpm.[1]

Two sets of sprockets are used. In both the sets all the sprockets are of 33 teeth. 2 sprockets are mounted on the center shaft; the rear shaft and the front shaft have one sprocket each.

The front and rear sprockets receive same high torque as they are on the center shaft. This torque is transmitted to both front and the rear shaft using a chain drive system. Since the sprocket on the front and rear shaft are same there will be no change in the torque transmitted and also the speed will remain same as the center shaft. The mechanism can be seen in the figure 1.[1]

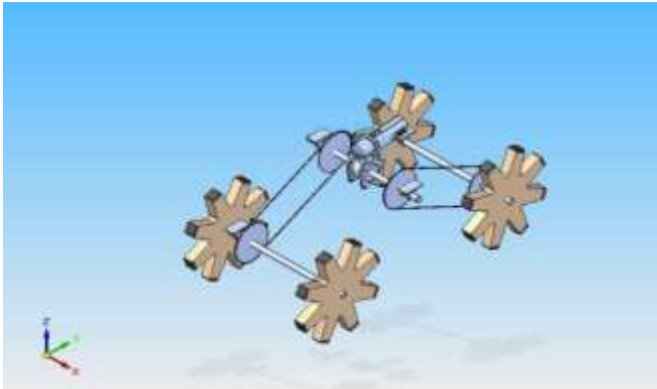


Fig1.Working Mechanism.



Fig.2 Prototype of Working Model.[2]

## 2.2 Intelligent Mutable Advanced Automated Wheelchair:

The basic structure consists of microcontroller, motor driver, smart phone, PC/Laptop, power supply and motors. The main aim is to construction of wheelchair having a direction control through voice commands, touches or hand gesture. A touchpad comprises a smart phone. When pressure is applied to the capacitive screen of smart phone, an XY coordinate location is produced and transmitted with Bluetooth available on smart phone to Bluetooth module (HC-05) available on wheelchair and the wheelchair will move in the desired direction. A change in location of the pressure will result in a corresponding change in direction. The touchpad also has a neutral or no movement point which will ensure efficient braking. This is very helpful for paralyzed and physically challenged people. Similarly, voice commands can be used as input to a decoder which converts a particular frequency of voice into digital bits for controller to process it and take desired action. Using voice operative mode the user can operate the wheelchair using pre-decided voice commands. The voice commands will be transmitted via Bluetooth available on smart phones. □ In hand gesture mode the user will be able to manipulate the wheelchair using hand movements. This is achieved by using accelerometer sensor available on smart phone which are used for gesture gaming. The data, as above, will be transmitted via Bluetooth. In automatic mode, the wheelchair is controlled by a host PC to traverse the route. This is very helpful to navigate in places such as home or where user is fully paralyzed. This feature can also be efficiently used if the patient feels ill and cannot regulate the wheelchair himself/herself. The patient will thereby be leaded to his/her home or paraplegic center safely.[2]

## 2.3 Wheelchair by triangular configuration of spur gear:

Methods which are followed on this Stair Climbing wheelchair are as follows:

1. A three way configuration of the spur gear is been introduced.
2. A single motor is been used for each pair of triangular configuration.
3. Chain drives are used for coupling these configurations.

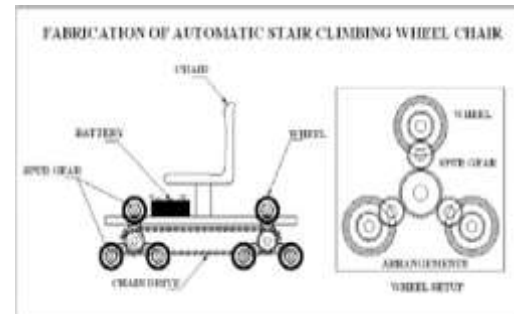


Fig3. Schematic sketch of gear assembly and Wheelchair.[3]

## 2.4 Mechanically operated Stairclimbing Wheelchair:

This concept consist of frame made by welding links, which acts as a rigid support for the chair. It has three main shafts, first two are connected by long chain and third connected to shaft chain. Chain transmits drive via motor to sprockets and further to shafts, This motion of shaft helps the track to climb the stairs with required traction.

**3. LITERATURE REVIEW:**

Fig4. working model of stair climbing wheel-chair[4]

**2.5 Analysis of Foot Step Wheel on Stair Climbing Wheelchair:**

The working of foot step wheelchair is consists of two operations such as climbs up & climbs down. For the user to climb upwards the following mechanism is employed. For climbing upwards, the hydraulic jack is made to be rest in its original position. When the jack is in original position, the seat that the user is being seated will be tilted in such a way so that the centre of gravity acts favourable to climb upwards. Due to this tilting of the seat the user will be made to sit in a certain angle that makes him to climb up easier.

For climbing downwards, the hydraulic is lifted to a certain extent so that the weight of the user acts downwards. Due to this lifting of the hydraulic jack along with the seat, the centre of gravity of the whole wheelchair is made to support the down climbing of wheelchair. This change will create a natural angle in the wheelchair. This angle will make the wheelchair to come down without any effort from the user.

All the user needs to do is use the brake for his safety. There will be slight vibrations in the wheelchair when the user fails to use the disc brake efficiently. This vibration can be counteracted by using some additional components. The braking action is made safer and efficient by using the disc brake. By the effective use of the disc brake, the down climbing of the wheelchair is made successful.

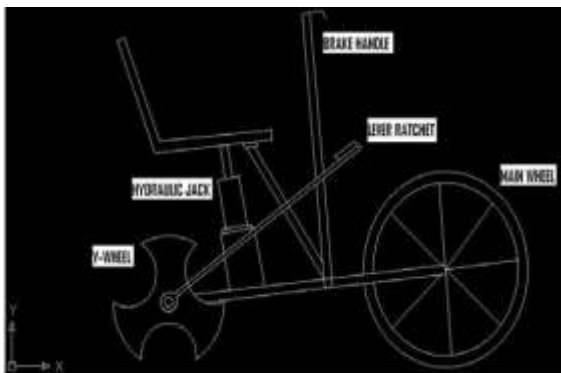


Fig.5 2D view of foot step wheelchair

- a) Rakshith R, Ritesh N Joshi, Suraj G D & Thrishool R designed the wheelchair which is compact and hence is able to climb almost all the stairs that we find at institutions, offices, industries and also at some homes. It has the ability to ascend a flight of stairs of 35-degree elevation carrying a weight of 55kgs.[1]
- b) Prashali Sharma , Shruti Kulkarni , Nilay Chowdhury , Pranamya Bandyopadhyaya & Tanay Chowdhury have described their prototype mode consisting of microcontroller, motor driver, smart phone, PC/Laptop, power supply and motors. The main aim of this project is construction of wheelchair having a direction control through voice commands, touches or hand gesture.[2]
- c) Nidhin Peous, Nikhil Mohan & Nitin Jose concluded developing a triangular configuration of spur gears. Geometry consist of three way spur gear pair arranged in manner such that they are able to climb over staircase.[3]
- d) Saddamhussain. N and Vasanthakumar. C concluded their design using Hydraulic Jack. For climbing upward Hydraulic jack will be in original position and seat with member sitting on seat will get lifted certain angle to nullify gravity. Use has to lift the lever for climbing up. For climbing downward, the hydraulic jack is lifted to a certain extent in order to nullify weight of user. While coming down user does not have to use any efforts. All he has to do is to break as and when required. Disc brakes are provided for braking.[5]
- e) S.M.O. Tavares, N. Viriato, M. Vaz, and P.M.S.T. de Castro have explained modes of failure of hydraulic cylinder with maximum load 1000N. They have also analysed the cylinder in ANSYS and came to certain conclusion.[6]
- f) Tadakamalla Shanmukh Anirudh and Jyoti Pragyan Satpathy have used track with rollers at both ends. Power to roller is transmitted from 2HP BLDC motor. Chair climbs the stairs as excavation moving on mountains. Standard commode facility is provided as it is mostly applicable for elder people in order to reduce efforts of transmitting them to toilet.[7]
- g) Michael Hinderer, Petra Friedrich and Bernhard Wolf introduced a model consist of two legs. It also has ultrasound sensors in order to detect the stairs and obstacles. Both the legs are independent to move. This legs works same as human legs.[8]
- h) Channabasavaraj B D, Ganesh N, Sachin N and Sumanth G Vaidya published paper consisting wheelchair. Assembly consist of 6 wheels, 2 belts, DC motor, etc. Rear two wheels are uplifted to a certain angle equal to angle of staircase and middle and front wheels are on flat surface. As it detects stairs, chain starts climbing backward adjusting weight of user.[9]
- i) K. Narendra Kumar, A. Gopichand, M. Gopala Anjaneyulu, B. Gopi Krishna have developed a robot consisting wheels connected to the arms. Frame of

the robot is adjustable. At the start of climbing single wheel is lifted up following by another, frame size is adjusted and then rear both wheels are lifted up. This way it climbs he stairs.[10]

- j) R Rajasekar, K P Pranavkarthik, R Prashanth, S Senthil Kumar and A Sivakumar have constructed the chain having different wheel geometry. It consist of 5 areas. Wheel is connected the end of the arm. Due to geometry, it climbs up.[11]
- k) Richard Simpson, Edmund LoPresti, Steve Hayashi, Illah Nourbaksh and David Miller have used navigation assistance software in order to navigate current position of wheelchair. Software is developed in C++. Language. Along with this, it uses drop off-detection sensor to detect the upcoming obstacles. Speed of the wheel chain depends upon the computational speed.[12]

#### 4. FUTURE SCOPE:

1. Chassis/Frame weight can be reduced by using lighter material than existing one e.g. Carbon Fiber, Aluminium, Aluminium alloy etc.
2. Hand gestures system, Joystick system can be implemented for ease of turning. The interface we had in mind was a simple joystick that controls the direction and speed of the wheelchair. This would remove the amount of skill required to operate the chair enabling a larger number of people to effectively use the chair.
3. Hydraulic Piston cylinder arrangement can be used for adjusting seat in order to nullify users weight. By using pressurized oil we can lift whole weight of person to balance the forces.
4. To improve ergonomics and aesthetics of wheelchair. Ergonomics is the key part of comfort to user. All handlings, controls and Seating facility should be developed considering ease in operation. While aesthetics give different impact visually, thereby it should be considered during designing.

#### 5. CONCLUSION:

In this paper we have studied different types of stairclimbing robots. Some of them uses spider gear mechanisms, climbing arms (like human legs), adjustable frame etc.

Main aim of this paper is to develop a Stair Climbing wheelchair, which is human friendly, low in cost and easy in operation.

This step towards development of technology in Stair climbing wheelchair will surely contribute to society.

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