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Design and Fabrication of Lever Propelled Wheelchair

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Abstract *- This paper includes the design and fabrication of lever propelled wheelchair. There are many people who are disabled due to some injuries or other drastic diseases. So there are various techniques used in the improvement of the conventional wheelchair. Researchers used the techniques like HMI, HCI and Accelerometer in the wheelchair. It improved the basic model but there are some people who cannot afford such advanced wheelchair. So in this design we are using the lever for transmitting the force to move wheelchair instead of applying the force on push rim. We are using the basic mechanisms for the movement of wheelchair. The wheelchair is designed in such a way that it requires less efforts and it is cheaper than the other advanced wheelchairs.*

Keywords: Lever propelled wheelchair, Design of Wheelchair, Fabrication of Lever Operated Wheelchair, Lever Mechanism, Chain Sprocket in Wheelchair.

I. INTRODUCTION

This work includes the design of lever propelled wheelchair. In the design of lever propelled wheelchair the wheels of bicycle will be used instead of push rim. The wheels will be rotated with the help of lever which will be attached to wheels by means of chain sprocket mechanism. The main motto of this project is to give the model which will require less effort than the conventional wheelchair and it will have low cost in comparison with the advanced wheelchairs available in the market. This concept is already being used in the tricycle but the tricycle cannot be used for indoor works as it requires more space. So in this project the concept is used in such a way that the wheelchair can be used for indoor works as well as for the outdoor works.

There are people who cannot buy the power wheelchairs for daily use. So this wheelchair will be the better option for such people.

II. LITERATURE REVIEWS

Now days researchers are so advanced and day by day they are inventing the advancement in every sector. Similarly there is huge improvement in the design of wheelchair. Some of the literatures which includes such improvement are reviewed.

2.1 Manual Wheelchair

The manual wheelchair has good indoor maneuverability and it is easy to steer in forward direction but for turning it requires more force also it requires high initial force to move. It may cause the damage in upper body of the patient. It has the disadvantage that it cannot be used for outdoor works. These push rim propelled wheelchairs are unable to be driven on the rough surfaces like grass, rocky places, ramps and sand surfaces.

2.2 Electric Wheelchair

The power wheelchairs are very advanced chairs that can be used by the person who have more disabilities other than legs. They comes with the facilities like seat elevation,

tilt, leg elevation, recline and other necessary features. So the people, who cannot move their legs and arms effectively, can use these powered wheelchairs.

2.3 Voice Controlled Wheelchair

The design of voice control wheelchair is based on the embedded system. The persons who are disabled both legs and arms can control this wheelchair by their voice. The wheelchairs have the voice recognition system which reads the voice and accordingly move the wheelchair in the given direction. The speaker dependent voice recognition processor and Arduino microcontroller are used as a voice recognition system.

2.4 Joystick Controlled Wheelchair

There are many people who have lower limb disability. For such people, there are many electric wheelchairs are commercialized and some of them uses joystick controller. These wheelchairs make their life easy and comfortable. In this paper, the joystick controller for wheelchair users is proposed. By using the joystick, the user can operate the nearby computer. This can be done by using the same joystick which is used for the movement of wheelchair without modifying the conventional electric wheelchair.

2.5 Lever Propelled Alternating Centre of Gravity Wheelchair

The priority of this paper is to introduce the wheelchair which will not require any external assistance to be moved. The user must be able to operate the wheelchair on his/her own comfortably and independently. This paper would also try to make a wheelchair which is affordable and versatile to be used in varied terrains and hence accessible to a complex diversity like India.

III. METHEDOLOGY

Introduction of Lever and Chain Sprocket Mechanism in Conventional Wheelchair:

The main function of the lever mechanism is to carry maximum load in minimum efforts. So this principle can be helpful for the patient to operate the wheelchair.

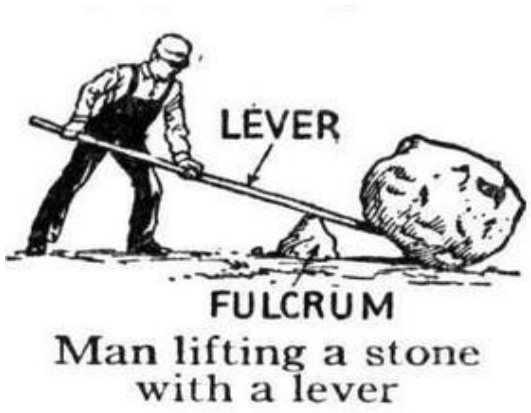

Fig. 3.1 Lever Mechanism

The patient will require less effort for more movement of the wheelchair. Indirectly, it increases the velocity of the wheelchair. Also another advantage is that the chain drive operated by hand lever offers low cost, easy maintenance and easy operation. Because the parts like wheels, chain and chain sprockets are the parts of the conventional bicycle, So for the maintenance and repairing, operator can find any cycle stores nearby. The main advantage is that the patient can move the wheelchair on rocky lands with very less effort. So this wheelchair will adapt these terrains like house floors, smooth roads and even rocky roads.

IV. DESIGN STAGES

According to the above mentioned methodology, the design started on the CREO Software. The design includes the main frame of the wheelchair, chain sprocket mechanism and the lever mechanism.

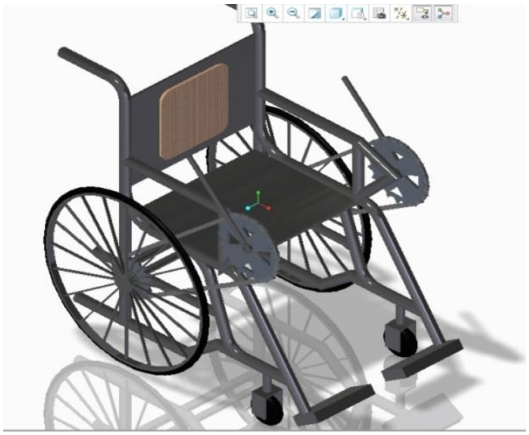

Fig. 4.1 CREO Model 1

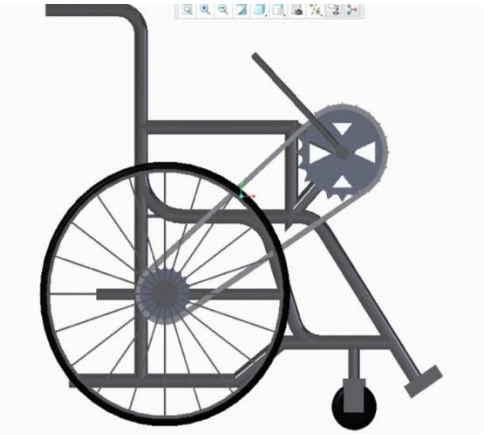

Fig. 4.2 CREO Model (Side View)

A. Main Frame:

The main frame of the wheelchair is the supporting member and main body for the wheels and seating arrangement. We followed the design of the tricycle for the frame so that the arrangement of wheels and seat will be more comfortable for the patient.

B. Chain Sprocket Mechanism:

We followed the design of bicycle for the chain sprocket mechanism. The smaller sprocket is freewheel which is connected to the wheels and the larger sprocket is a gear of the bicycle. We used the single strand chain drive for the motion transfer. This chain sprocket mechanism is provided on both the sides of the wheelchair which will provide smooth motion and also will be helpful for turning the wheelchair on either side.

C. Lever Mechanism:

The lever mechanism is nothing but the MS rods which are attached to both the larger sprockets. The braking levers are attached with these two levers to balance the wheelchair motion. If both the levers moved forward, the wheelchair will move forward. If one of the levers is held still and the other moved forward, then the wheelchair will move towards left or right side accordingly.

V. FABRICATION STAGES

A. Primary Stage

In the primary stage the main component of the wheelchair had to be made. So for the frame, the MS rods were bought. Mild steel rods are being used in conventional wheelchair. The dimensions of the frame were taken from the wheelchair and tricycle model. The primary frame is fabricated by using cutting and welding process. A hand cutter was used for the cutting operation.

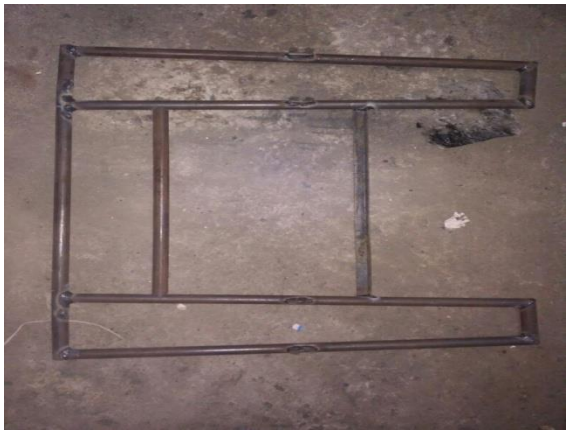

Fig. 5.1 Main Frame

B. Secondary Stage

In the secondary stage the wheels and castors are attached with the frame. This is done in such a way that the wheelchair should be balanced. The centre of gravity should be same for the patient and the wheelchair. So taking these concepts in consideration, the frame is modified.

Fig. 5.2 Frame with wheels and castors

C. Final Stage

The final assembly of the wheelchair is done and the main challenges were how to fix the lever with the sprocket along with the brakes. The hand lever of mild steel pipe of 660mm length is attached to the larger sprocket in such a way that the person would feel comfortable while operating the lever. The brakes attached at the end of the levers for stopping the wheelchair manually. Finally the backrest, seat, armrest are assembled. The wheelchair is painted well for corrosion resistance.

Fig. 5.3 Final Stage

Fig. 5.4 Side View of Wheelchair

VI. CALCULATIONS

Length of Handle = 660mm

Average Human Force = 500N

Torque on Sprocket = Force on Handle * Length of Handle

= 500 * 0.66

T = **330 N-m**

We have, P = 2*3.14*NT/60

Also, Average Velocity, V = 0.8-0.9 m/s

Diameter of Wheel = 741.2mm

Therefore, V = 3.14 * D * N/ 60

0.85 = 3.14 * 0.7412 * N/ 60

N = 21.90 rpm ~ 22 rpm

Power = 2 * 3.14 * N * T / 60

P = 2 * 3.14 * 22 * 330 / 60

P = 760.25 W (Rated)

- **Design Power (Pd) :-**

From DDB Table No- (XIV-1) & (XIV-2)

$P_d = P_r * Kl$

Considering Uniform Loading,

Kl = 1

P_d = 760.25 * 1

P_d = 760.25W

Therefore, P_d = 760.25/ 746 **HP**

P_d = 1.019 HP

- **Pitch & No. Of Strands :-**

From DDB Fig. 14.1 on P-152

For smaller sprocket running at 202.92rpm & P_d = 1.019 HP, following alternative is suitable.

From Fig.14.1 of Design Data Book,

1. No. Of Strand = Single Strand
2. Chain No. = 50
3. Pitch = 15.875mm

- **Centre Distance :-**

From DDB Table No XIV-3

C = Dia. of larger sprocket + ½ Dia. of smaller sprocket

C = 180 + (1/2 * 80)

C = 220 mm

- **Length Of Chain In Pitches :-**

From DDB Table No.XIV-1 $L = ((T1 + T2)/ 2) + (2C / p) + p(T1 – T2)^2 / 40C$

We have,

T1 = No. of teeth on larger sprocket = 44,

T2 = No. of teeth on smaller sprocket = 18,

C = Centre distance = 220 mm

p = Pitch = 15.875 mm

L = 59.93 mm ~ 60 mm

- **Case 1**

Torque = 330 N-m

For Larger Sprocket,

No. of Teeth = 44,

Dia. of Sprocket = 180 mm

Therefore,

Torque on Sprocket = Tension on Chain Drive * Radius of Sprocket

330 = Tension on Chain Drive * 0.09

Tension on Chain Drive = 330/0.09 =3666.67 N

- **Case 2**

For smaller Sprocket,

No. of Teeth = 18,

Dia. of Sprocket = 80 mm

Therefore,

Torque on Freewheel = Chain Tension * Radius of Sprocket

= 3666.67 * 0.04

Torque = 146.67 N-m

- For Conventional Wheelchair,

Velocity of Wheelchair = Speed of Conventional Wheelchair * Circumference of Wheelchair

RPM of Wheel = Velocity / Circumference

= 0.85 / 2 * 3.14 * R_W

= 0.85 / 2 * 3.14 * 0.35

= 23.66 rpm

Torque on Wheel = Force on Rim * Radius of Wheel

= 500 * 0.35

= 175N-m

- For Our Wheelchair Model

Velocity of Wheelchair = Speed of Conventional Wheelchair * Circumference of Wheelchair

RPM of Wheel = Velocity / Circumference

= 1.5 / 2 * 3.14 * R_W

= 1.5 / 2 * 3.14 * 0.35

= 0.682 rps

= 40.92 rpm

So it is clearly seen that by modifying the wheelchair by adding lever and chain sprocket mechanism, the velocity of the wheelchair increased. For moving on smooth terrains, the wheelchair will give more velocity in less effort.

VII. RESULTS

We designed and fabricated the lever propelled wheelchair. The lever with the chain sprocket mechanism is used for the propulsion. The parts of the conventional bicycle were used. So reduction in the cost is done. Also as we used the bicycle wheels, the maintenance and repairing can be done in the nearby cycle stores. The wheelchair also provides the mechanical advantages like it can be easily operated on smooth and rocky terrains. We also provided the push rim. If the patient is tired and can't operate the levers, anyone can help him to move by using this push rim. The braking system is not so complicated and easily maintainable. We used the brakes of bicycle so giving more comfort for braking. The main reason behind selecting the lever propelled mechanism is to get more velocity for easy and convenient usage by the patient.

VIII. CONCLUSION

We were able to successfully design and fabricate the lever propelled wheelchair. We also demonstrated the increase in velocity in our wheelchair than the conventional one through our calculations. We successfully tested the wheelchair on smooth as well as rough terrains. The results were positive and we achieved the higher velocity than the conventional wheelchair. Also the effort required to move the wheelchair was less than that in the conventional wheelchair.

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