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Design of Stair Climbing Wheel Chair With Prototype

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ABSTRACT:
The person who lose legs or permanently handicapped person who have no control on their legs, they are used to move one place to another place using various types of wheel chair. But in that types of chairs stair climbing function is not provided and they faces so much problems. In this paper, present the stair climbing wheelchair which can be operated by handicapped person without any help of support systems or persons. In this design the center of gravity of whole device will be transferred to the back side of wheelchair. It consists of pulley-rubber crawler mechanism.

Keywords: Stair climber, Rubber crawler, Handicapped Person, Change C.G, Semi Automatic.

I. INTRODUCTION

In so many government organizations, schools, buildings have no special facilities like elevators and slopes for handicapped persons. Slope or Ramp angle can be increased up to 4.8 degree which can be climb by manual operated wheel chair. Whenever slope angle increased from 4.8 degree, wheel chair need to be supported by another person. Elevators and slopes are required specific space in buildings. The cost of elevators is so much higher than this wheelchair. When carrying a person in a lightweight wheelchair the number of assistants may vary from two to four, depending on the weight of the passenger and the strength of the assistants vary. Means for stair climbing and descending requires more than single person. It is not economical and risky operation.

II. Modelling of device with components

This wheelchair is semi-automatic device which can travel on rough, plain surface and climbing & descending stairs. Operation of the wheelchair electric energy is supplied from battery to motor. Then pulley is rotated by motor. Positive traction is achieved between pulley and rubber crawler by internal thread. Due to movement of rubber crawler wheelchair can starts travelling.

A. Main Component Of Stair climbing Device:-

- Chassis
- Pulley
- Rubber crawlers
- Battery
- Motor

(a). Chassis: It is made from the hollow rectangular -section.
Material for chassis side & cross member- St 52 steel [1]
Chemical composition-C-0.20, Si-0.50[1]
Yield strength-355 Mpa[1]

Calculation of rolling resistance to propel the wheelchair[3]:-
Rolling resistance = 22.7395 N
Motor power is 208 W [2], according to that torque calculation for wheelchair are
When up stair :
For pulley $N = 13.8\ rpm$
Speed $V = 6.5 m/min$
Power $P = 208\ W$

Torque [3], $Te = P * \frac{60}{2\pi N}$

$$Te = 144.0\ N.m$$

Tractive force = 1920 N
When down stair :
For pulley $N = 16.3\ rpm$
Speed $V = 7.7 m/min$
Power $P = 208\ W$
Torque,[3] $Te = P * \frac{60}{2\pi N}$

$$Te = 121.91\ N.m$$

Tractive force =1625 N
Here both tractive force are greater than the rolling resistance so we conclude that motor is able to propelled the wheel chair.

(b). Pulley

Table 1. Pulley [4]:

Specifications:	
Pulley outer diameter (D)	153mm
Pulley inner diameter (d)	145mm
Pitch diameter (p)	149mm
Hole diameter	30mm
Material	Nylon 6-6

(c). Rubber crawlers

Table 2. Rubber crawlers[4]:

Specifications:	
Pitch	50mm
External Thread height	20mm
Internal Thread height	10mm
External Thread pitch	50mm
Internal thread pitch	11.5mm

III. Modeling of Device using creo 2.0

(Figure-1) Assembling of rubber crawler with pulley drive. Rubber crawler provide the mobility to the wheelchair whenever its climb up the stairs. (Figure-2) Seating position of handicapped person while wheelchair is run on flat surface.

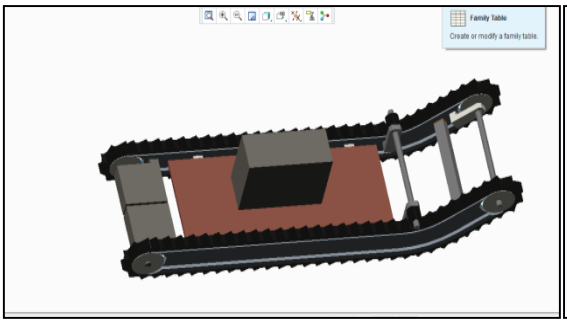


Figure 1. Chassis(Creo 2.0)

Figure 2. Mankin with Device (Creo 2.0)

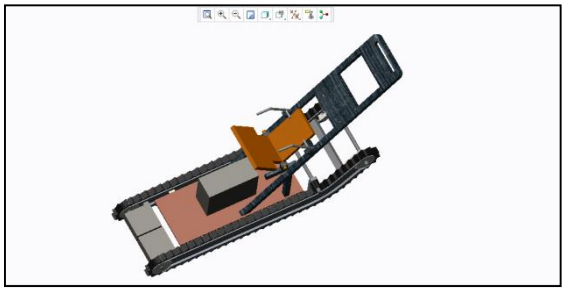


Figure 3. Change C.G of device

(Figure 3) We are design the seating arrangement which transmit the center of gravity of person from mid point of wheelchair toward backside. Whenever the wheelchair start a climbing up the stairs, back of person makes 45 degree with vertical axis.

IV. RESULT AND DISCUSSION

Our main concept is to change center of gravity of wheelchair while climbing the stairs. By use of this concept we were fabricate prototype of wheel chair. In that prototype we also use pulley rubber crawler mechanism. C.G. of wheel chair is changed by seating position of person by using electrical cylinder.

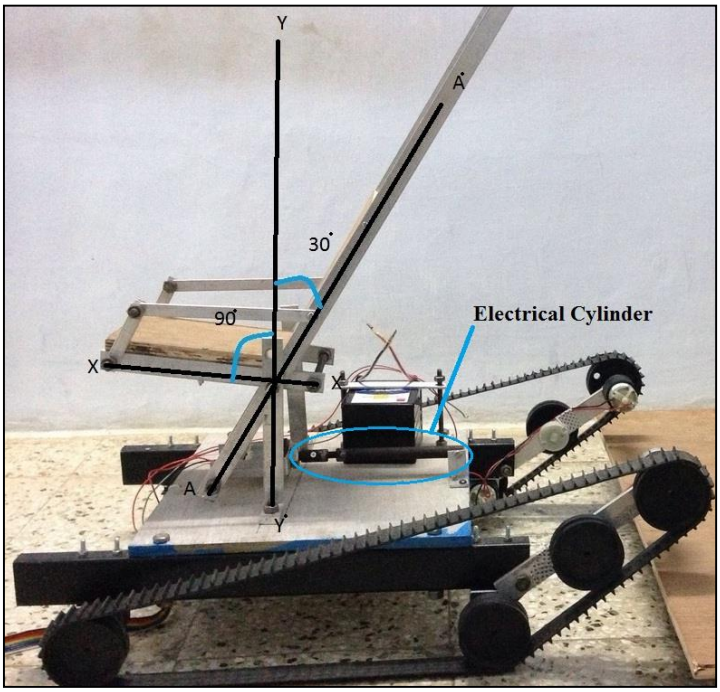


Figure 4. Prototype on flat surface

In figure 4 we mention X-X' line which normal to the Y-Y' line and A-A' line makes the 30 degree with Y-Y' line. X-X' line and A-A' line are represent the seating position. They do not change their angular position to each other. Whenever user start the climbing the stairs at the same time he/she apply the power to the electrical cylinder. The electrical cylinder change the seating position of person by pushing A-A' line. By above process the A-A' line increase the angle with Y-Y' line and angle increase up to 45 degree. Process of changing angle of A-A' line with Y-Y' line avoid chance of tumbling and provide stability to device.

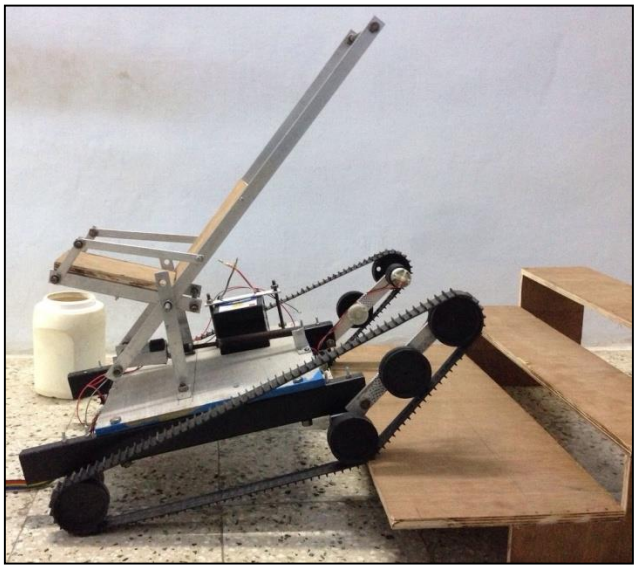


Figure 5. Position on first step

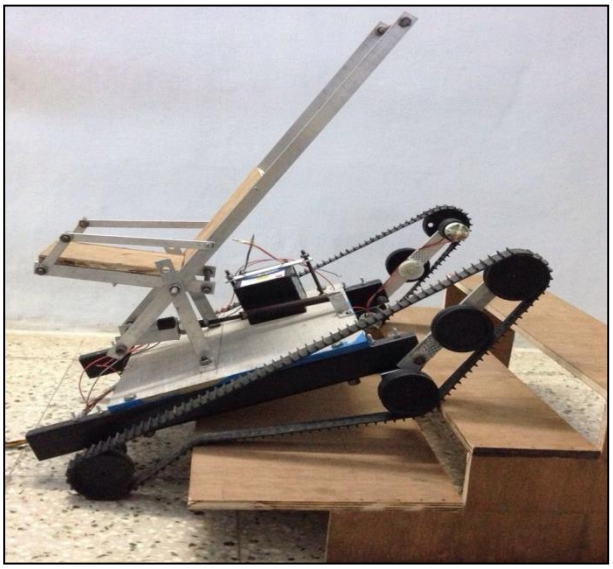


Figure 6. Position on second step

Figure 7. Position on third step

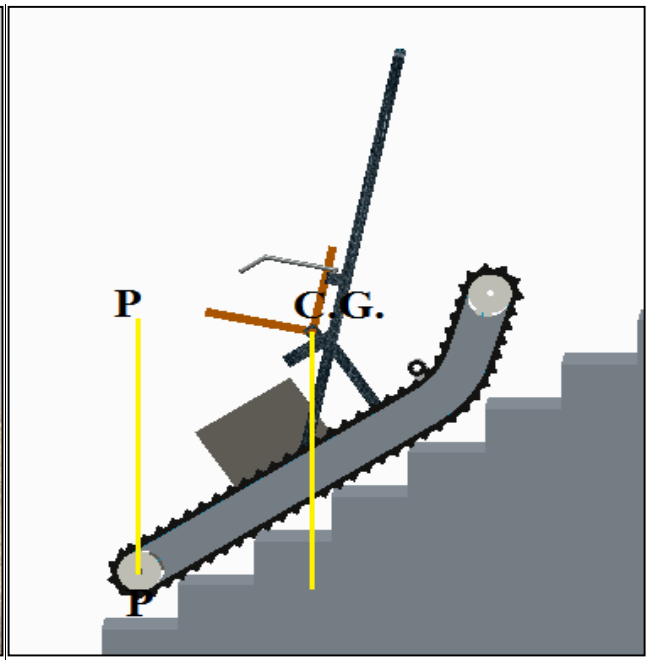
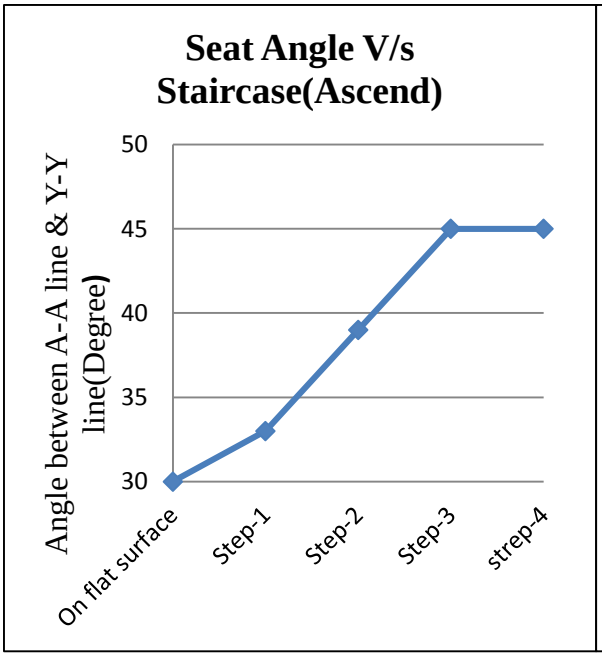
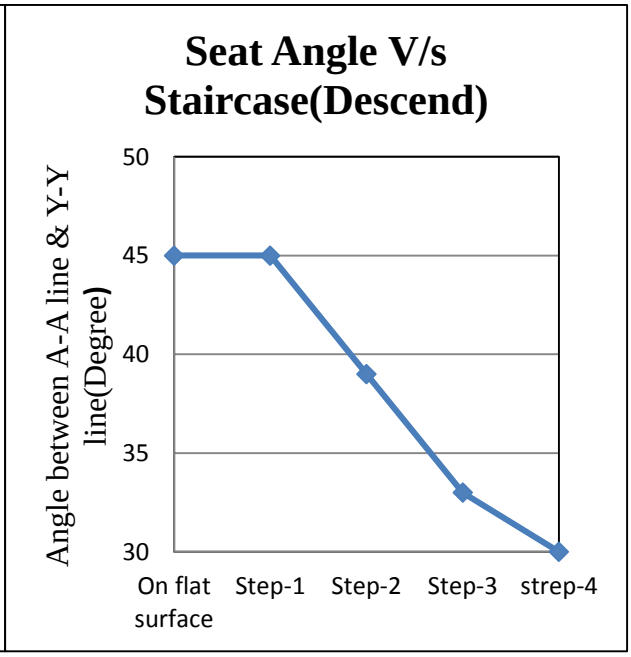


Figure 8. Position of C.G.(Creo)

By use of process of change the location C.G we are trying to move line of action of C.G away from centerline of rear pulley (this is represented in figure 7 & 8).The line P-P' is passing from center of rear pulley. This helps to reduce chances of overturning or tumbling **.[5]**



Graph 1: Ascending the staircase



Graph 2:Descending the staircase

The graph 1 representing the angle between the A-A' line and Y-Y' line with respect to the steps of the staircase (The A-A' line and Y-Y' line are shown in fig. 4).

- On flat surface : While wheelchair is run on the flat surface angle of A-A' line with Y-Y' line is 30degree.
- Step-1: Whenever wheelchair start climbing the first step angle between A-A' line and Y-Y' line increasing from 30degree to 33 degree.
- Step-2: While wheelchair start climbing the second step angle increasing from 33 degree to 39 degree.
- Step-3: While wheelchair start climbing the third step angle increasing from 39 degree to 45 degree.

- Step-4:After the third step of staircase the angle between A-A' line and Y-Y' line is remaining constant until the wheelchair reach to the last step of the staircase.

(The process of changing the angle is done by the handicapped person.)
The graph 2 representing the angle between the A-A' line and Y-Y' line with respect to the steps of the staircase(while descending).The process of descending is reverse to the ascending the stair case mentioned above.

V. CONCLUSION

This designed stair climbing wheelchair can climb up stairs up to angle of 30 degree. In this wheelchair rubber crawler provide proper grip on step while climbing up stair cases. It can be operated by handicapped person without help of any person. It can also climb maximum step height up to 180 mm. This track based wheel chair is not depend upon the tread width, no matter tread how much long but it can climb up stair case angle up to 30 degree. Maximum payload was 80 kg. It can travel on rough as well as flat surface.

In layman terms, some future steps have been proposed and some practical steps have been taken towards "even better steps for human and humankind" a vision of providing mobility equality for all.

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