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Design and Fabrication of Stair Climbing Wheelchair with Rocker Bogie Mechanism

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Abstract: Rocker bogie finds a vital role in determining the scientific analysis of objectives separated by many distance apart. The mobility design at present is quite a bit complex with many legs or wheels. The wheeled rover which is capable of driving over the rough terrain provided with high degree of mobility suspension system.The drive provided by the rocker bogie is simple and it mainly operated by the means of two motors.The motors are kept inside in order to make it more reliable and efficient.In overcoming the bumps in the natural terrain the wheels are operated simultaneously.By implementing this mechanism the vehicle can come through any obstacles it faces during the travel in the terrain.We have tested it by conducting a series of mobility experiments on agricultureland,rough roads,inclined,stairsandobstaclessurfaces and concluded that it is possible to implement. This project mainly focuses how the mechanism finds its place in the wheel chair.

Keywords-Wheel Chair, Rocker Bogie Mechanism

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I. INTRODUCTION

In order to have his life on earth man must find a way to earn. As the time goes on we must remember of deprived people.We need to find a way to support such a individuals with deprived legs,hands or other parts of the body.They were too dependent on others for everything,so we need to understand their feelings and provide a way to carry out their life.It is difficult for them to migrate from one place to other.The mobility of an individual is being restricted.The small scale manufacturers were keen on their efforts to develop the cycle that suits them but it is not in the case of other transportation facilities.The tricycle invention provided them with increased mobility and independence.So we had an idea of inventing a wheel chair with rocker bogie mechanism.It consists of motor,battery,links and wheels.The suspension design used in this mechanism offers vehicle stability.The rocker bogie suspension finds its first application in Mars Exploration Rover project.

II. MOTIVATION OF THE WORK

Daisuke Chugo et al.(2006) developed a mechanical design of holomonic mobile vehicle that is capable of running over irregular terrains.The performance of vehicle on rough terrain was increased by using passive linkages in the design. The previous versions of passive linkages which were implemented in this design those where found to improper as their body configuration cannot fit the terrain surface and wheels cannot transmit its traction force. Theirprototype mechanism consisted of seven special wheels with free rollers and a passive linkage mechanism. The passive linkage mechanism ensured that the vehicle can pass over the step smoothly when the wheel contacts the step, changing the body configuration of the vehicle. No sensors and no additional actuators are required to pass over the non-flat ground.Rajasekar P et al.(2013) proposed and fabricated a manually operated wheelchair that can travelonboth plane terrains and also in the staircases. This design primarily aims at providing stability to the person who travels in the wheel chair and with minimum manufacturing cost. Instead of using normal wheels they have used penta wheel. The steel rod is penta shaped and each rod is equally inclined of 72° from each other. At the time of climbing, one wheel that is the idle wheel will be in contact with the ground and the wheel will be in contact with the stair. NitinYadav et al.(2015) discussed about the mechanical design and its advantages of Rocker- bogie suspension system in order to find suitability to implement it in conventional loading vehicles to enhance their efficiency and also to cut down the maintenance related expenses of conventional suspension systems. They observed that that the main problem associated with current suspension system installed in heavy loading vehicles is their slow speed of motion which derail the rythem to absorb the shocks generated by wheels .They proposed a design a design which aimed at increased at increasing the rocker-bogie mobility system in conventional heavy loading vehicle

behavior when high speed traversal is required.ChinmayaSukhwal et al. (2016) presented a design of wheelchair for the people suffering from disabilities such as motor impairment. The proposed design mainly focuses on enhancing thewheelchair with the low-level stair climbing feature. The measurements for the wheelchair are selected according to the standardanthropremetric measurements. The proposed wheelchair has been particularly designed to perform stair climbing operations as well as mobility through uneven terrain. The dimensions of the wheelchair seat has been taken with respect to standard measurements of an adult human being as specified by ADA, whereas the dimensions of the frame and wheels are based on the assumption of conventional staircase at home environment.S.F.Toha (2015) proposed an intelligent inclined motion control of an amphibious vehicle while moving on uneven terrain surface. The trainability helps the vehicle reducing a flipping back and slippage while it on a mission since the terrain surface after a disaster is unpredictable. Thus, applying the controller algorithm will optimizing the vehicle ability to manoeuvre in any surface condition with minimum risk.

III. OBJECTIVES OF THE PROJECT

The objective of using this mechanism is to reduce the energy consumption and the center of mass of the rover is displaced vertically.The main objective of this project is to provide a comfortable riding for the unable person to climb stairs without being dependent on others for help. It can also help us to travel in the unterrain areas with little effort.

IV. DESIGN OF WHEEL CHAIR WITH ROCKER BOGIE MECHANISM

The determination of dimension of rocker and bogie linkages is the key factor in manufacturing of rocker bogie mechanism. Based on the requirements, the dimension can be varied. The main aim of this project is that it overcomes obstacles up to a certain height and up to a certain angle. We assumed stair case of certain height and length, and then by using the Pythagoras theorem, we came up with dimension of the chair. In order to achieve a greater stability only one pair of wheel must be at the rising position. To find the dimension of the linkages we have toplacethe first pair of wheels horizontally, next pair is placed before rising.A suitable distance is maintained between them.

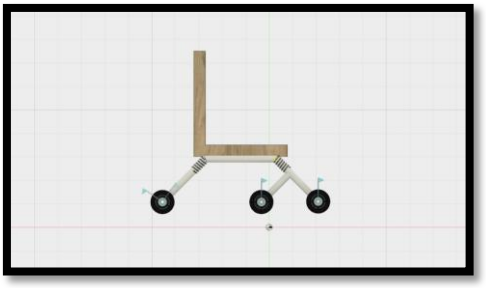

Fig. CAD Modeling of the Proposed Wheel Design Calculation

Assumption of the obstacle is as follows:

- 1.The length of the obstacle l = 600mm
- 2.The breadth of the obstacle b = 300mm
- 3.The height of the obstacle h = 200mm

In rocker bogie mechanism

- Angle ABC, Angle ADE=90°

Using Pythagoras Theorem, to find height h

- Area=1/2absinc=1/2*21*21*sin30
- Area=110.25 cm^2
- Area=1/2bh
- h =2*Area/b
- h =7.35cm

Tofind:H

- Area = ½pqsinr = ½ *42*42*sin60
- Area = 763.82cm^2
- Area = ½*B*H
- H = (2*763.83)/60
- H= 25.461cm= 254 mm

In order to find the Tilt angle (θ)

- θ = $\tan^{-1}(y/x)$ = $\tan^{-1}(20/30)$; θ = 33.7°

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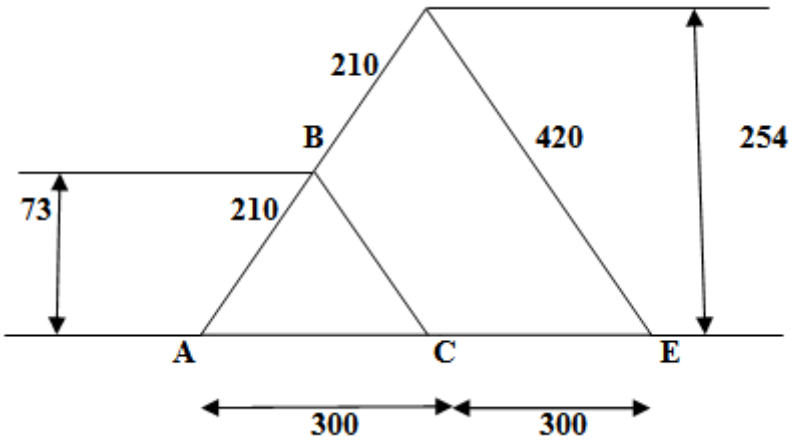

Fig.1.3 Dimensions Of Mechanism

a. Selection of motor

For mainlyheavyobjectsathightorque motor isrequired.

- τ = F*r
- F = m*a = 2*9.8 = 19.6 N = 20 N (approx.)
- τ = 20*0.55= 11Nm

Since inthe markettorqueisexpressedinkgcm ,
We get τ= 10kgcm

C. Calculationof Torque

The torque can be calculated by using the formula

- τ = F *r
- τ = 20*5.5 = 6 Nm

Assumingwheeldiameter as110mm .Weget

- v = (π *d * n)/60

Tofind N(rpm)N=(v*60)/(π*D)[assume that the velocity= 0.3 m/s] , N =(0.3*60)/(π*1.10) = 57.2 rpm
ThenN= 42rpmas N= 60rpm
We selectmotoroftorque = 10kgcm
Consider ΔABC,

- $AC^2 = AB^2 + BC^2$
- $AB^2 = BC^2 – AC^2 = 2AB^2(300)^2 = 2(AB^2)$ AB =212mm

Since AB =212.13mm =212mm (approx.)
We getBC =21cm
Consider ΔADE

- $AE^2 = AD^2 + DE^2$,
- AD=DE
- $(600)^2 = 2\ (AD^2)$
- AD = 42.42cm
- AD=DE=420mm

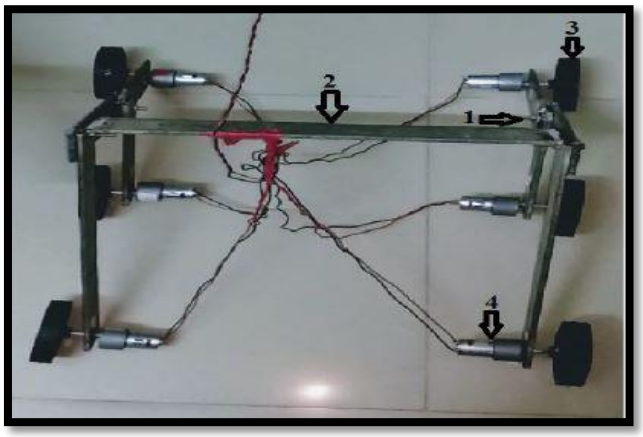

Fig 1.5FabricatedModel of the wheel

V. ADVANTAGES

The advantages of wheel chair with the addition of rocker bogie mechanism is as follow

- It provides us with a easy installation.
- The speed can be controlled over a very wide range.
- It provides a high starting torque.
- Quick starting, stopping,reversing and acceleration can be done with ease.
- It can climb upto obstacles with vertical height equal to twice of its diameter.
- The vehicles based on rocker bogie suspension can traverse terrains like desserts, snow and swamp etc. easily because of higher tractive force obtained due to presence of 6 wheels.

VI.CONCLUSION

This project makes it way over the rough terrain.The torque developed will be based on the weight acting on the each of the links.By having accurate measurements of stair we could have a chair with much greater stability.When the chair's rear end faces the stair edge,the posture of the chair is poor.It undergoes a smooth travelling while it travels in the ascending fashion but while coming down it comes up with vibration.So we planned to have a spring and braking system.We put forward with mechanical design for the passive linkages.When the vehicle is made contact with the step the momentum is being calculated from which the moment force of the free joint is carried out.Atlast we cross checked the values with the computer simulation software.Here the mechanism is equipped with the minimal control system and successfully tested by moving it over the stairs in the forward and in the reverse direction.

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