Design and Fabrication of Rocker Bogie Mechanism with Stair Climbing

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Abstract— The Rocker-Bogie Mobility system was designed to be used at slow speeds. It is capable of overcoming obstacles that are on the order of the size of a wheel. However, when surmounting a sizable obstacle, the vehicles motion effectively stops while the front wheel climbs the obstacle. This paper demonstrate the Rocker Bogie Mechanism and its traction control using a micro controller. The model here represent simplest yet effective way of rocker bogie traction system, which can be used in every application dealing uneven terrain surface.

Keywords: Rocker Bogie Mechanism, Stair Climbing

I. INTRODUCTION

All the Mars rovers have six wheels and use a rocker-bogie suspension system to drive smoothly over bumpy ground. There is one rocker-bogie assembly on each side of the rover. The rocker is the larger link that connects to the rover body (the chassis) in the middle (at the rocker pivot), has a wheel on the back, and connects to the bogie in the front. The bogie is the smaller link that connects to the rocker in the middle (at the bogie pivot), and has wheels at both ends. Each of the six wheels has its own motor. Robots using rocker bogie mechanism make use of a suspension robots were heating to hurdles and then it was leading to property damage, Robot mechanism that consists of several rigid elements connected through joints of a certain number of degrees of freedom. The suspension has 6 wheels with symmetric structure for both sides. Each side has 3 wheels which are connected to each other with two links. The main linkage called rocker has 2 joints. while first joint connected to front wheel, another joint assembled to another linkage called bogie, which is similar to train wagon suspension member.

II. OBJECTIVES

Now the objective of the project is to make sense the hurdles and make the mechanism of to lift the wheel of robot when there is hurdles. And to avoid the damage of suspension system and property damage. This robot is operated by one person so there a no required much people for operate, if that why it causes to reduce man power.

III. PROBLEM STATEMENT

As we see the development in technology. It is being very common to use mobile robots in construction sites and industries. But there is a problem that the existing robot was not able to sense the hurdles. Those suspension damage and the productivity loss on sites.

IV. LITERATURES

Design of Stair-Climbing Rocker-Bogie Mechanism 2018, by Abhaykant Sinha 1, Reshma Sinha 2 Bachelor of Technology (Mechanical Engineering), SBSSTC, Ferozepur, Punjab, India1 In planetary exploration, Rocker-Bogie Mechanism will continue to play a significant role. Present mobility designs are complicated, using number of wheels or legs. They are not built up to mechanical failure initiated by the tough environment on Mars. Four-Wheeled rovers are capable of navigating rough terrain using an effective high degree of mobility suspension system.

Design of Rocker Bogie Mechanism 2017, by, D. S. Chinchkar1, S. S. Gajghate2, R. N. Panchal3, R. M. Shetenawar4, P. S. Mulik5: Rocker bogie are important for conducting in-situ scientific analysis of objectives that are separated by many meters to tens of kilometers. Current mobility designs are complex, using many wheels or legs. They are open to mechanical failure caused by the harsh environment on Mars.

V. CONSTRUCTION

A. DC Motor:

Fig. 1: DC motor

An electric machine which convert electrical energy into mechanical energy. The working principle of DC motor is that whenever a current carrying conductor places in the magnetic field it, experiences a mechanical force DC motor the input electrical energy is the direct current which is transformed into the mechanical rotation. We will be using 30 rpm motor with 12V DC motor the electrical motor are electro mechanical device that produce motion by turning electrical energy into mechanical one.

B. Wheels:

Fig. 2: Wheels

Wheels are usually in the pairs, connected by a rod of wood or metal known as an axle. While our wheel design may not be optimized in term of strength and weight reduction. Our project wheel diameter is 100mm.

C. Battery:

Fig. 3: Battery

A thermoplastic material derived from common salt & fossil fuels the pipe material has the longest track record of all plastic materials. Our project pipes material is the acrylic, So this is transparent plastic material with outstanding strength, stiffness and optical clarity. Our project pipes Diameter is 25mm.

D. PVC Pipe Material:

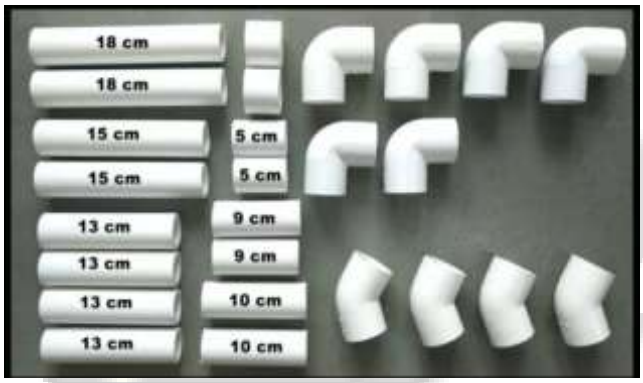

Fig. 4: PVC Pipe Material

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E. Motor fitting Clamp:

Fig. 5: Motor fitting Clamp

A tool that you use for holding two things together very tightly. The rounded clamp is used to our project. To hold something very firmly in a particular position. Our project Motor fitting clamp material is stainless steel.

F. Control Device:

Fig. 6: Control Device

A piece of equipment for controlling something from a distance. It is the DPDT (Double Pole, Double Throw) Switch.

G. Wire and Cables:

Fig. 7: Wire and Cables

Wire is used to carry electricity to bear the mechanical load, to transmit telecommunication signal. Power transmission for telecommunication signal or to carry electricity. Our project (black, white, blue, red etc.) colored wires used.

H. Working Principle:

Fig. 8: working rocker bogie mechanism

The Rocker - Bogie design has no spring and stub axles for each wheel, allowing the rover to climb over obstacles such as rocks, which are up to twice the wheel's diameter in size while keeping all six wheels on the ground. As with any suspension systems. The tilt stability is limited by the height of the center of gravity. Systems using springs tend to tip more easily as the loaded side yields. Based on the center of mass, the curiosity rover of the mars science laboratory mission can withstand a tilt of at least 50 degrees in any direction without overturning, but automatic sensor limit the rover from exceeding 30 degree tilts. The systems is designed to be used at slow speed of around 10 cm/s, so as to minimize dynamic shocks and consequential damage to the vehicle when surmounting sizable obstacles. In order to go over a vertical obstacle face, the front wheels are forced against the obstacle by the center and rear wheels. The rotation of the front wheel then lifts the front of the vehicles up and over the obstacle. The middle wheel is then pressed against the obstacle by the rear wheels and pulled against the obstacles by the front until it is lifted up and over. Finally, the rear wheel is pulled over the obstacles by the front two wheels. During each wheel's traversal of the obstacle, forward

progress of the vehicle is slowed or completely halted. The speed of our project 30rpm. And choose the high rpm motor to increase the speed. This is not an issue for the operational speeds at which these vehicles have been operated to date. One of the application of rovers will be to assist astronauts during surface operation. To be a useful assistant. The rover will need to be able to moves much faster than human walking speed or at least equivalent.

1) Calculations 1:

1) Diameter of Wheel:
= πDN/60
Assumed speed be 10 cm/s i.e.
100mm/s
Therefore,
100=πDN/60
DN=1909.86mm
So the selected DN combination
D = 100 mm, N = 190.09 rpm
2) Calculation of Wheel Base

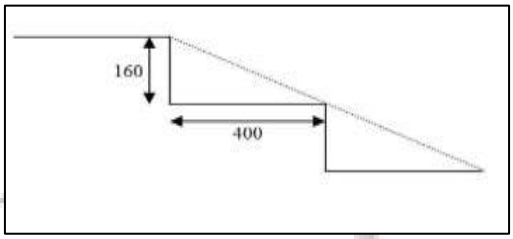

Fig. 9: Centre Stage Stair

$\theta = \tan^{-1}{}_{x}^{y}$
$= \tan^{-1}{}_{400}^{160}$
$\theta = 21.80^{\circ}$

3) Calculate the Wheel Base,
=Total length – (radius of front wheel + radius of rear wheel)
=400-(50+50)
Wheel Base = 300 mm Total Wheel base = 300 mm
Let us assume, Θ=45˚
In Triangle BNC, angle BNC = 90˚
Angle NBC = Angle NCB = 45˚
Therefore, NC = NB
NC2 + NB2= BC2.....Pythagoras Theorem
BC2 = 2(NC)2…….(1)
= 2(165)2
=54450
Therefore, BC
= 233.33mm Rounding off to 230mm.
BC = 230 mm
Substituting to eqn (1) we get,
$230^2 = 2(NC)^2$
NC = 162.63
Also, AN = NC = 162.63 mm. In triangle AMN, angle AMN = 90
$AM^2 + MN^2 = AN^2$ (Pythagoras Theorem)
2AM2 = AN2
$2AM^2 = 162.63^2$
AM = 114.99 AM=115 mm
Now, due to symmetry,
AM = MN = 115 mm
BM = AB – AM
=230 – 115
=115 mm
Therefore, BM = 115 mm
4) Height Calculation:
$Height^2 = BC^2 – NC^2$
$(230^2 – 162.63^2)^{1/2} = 162.639$ mm
Net Height = 162.639 + 35
Net Height= 197.639 mm
5). Track Width:
= 2h
1.3 = 2 ×197.639
= 513.86 TW = 513.86

2) Calculation 2

6) Calculation of Wheel Base

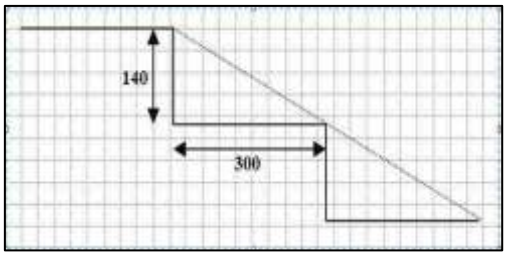

Fig. 10: Library Stairs

$\theta = \tan^{-1}{}_{x}^{y}$
$\theta = \tan^{-1} \times (140/300)$ θ = 25.014˚ wheel base = Total length – (radius of front wheel + radius of rear wheel) = 300-(35+35) = 230 mm

7) Length of Links

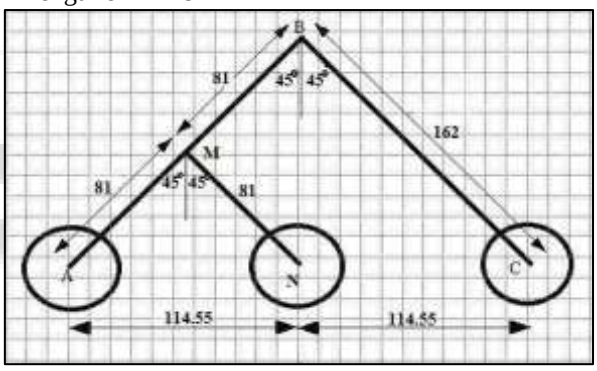

Fig. 11: Calculation at Library Stairs

Total Wheel base = 230 mm
Let us assume, Θ=45
In Triangle BNC, angle BNC = 90˚
Angle NBC = Angle NCB = 45˚
Therefore, NC = NB
$NC^2 + NB^2 = BC^2$
(Pythagoras Theorem)
$BC^2 = 2(NC)^2$ … (1)
$=2(115)^2$
= 26450
BC = 162.63 mm
Rounding off to 162 mm
BC = 162 mm
Substituting to eqn (1) we get,
$162^2 = 2(NC)^2$
$26244 = 2(NC)^2$
$13122 = (NC)^2$
NC = 114.55 mm
Also, AN = NC = 114.55 mm
In Triangle AMN, angle AMN = 90
$AM^2 + MN^2 = AN^2$ … (Pythagoras Theorem)
$2AM^2 = AN^2$

$2AM^2 = 114.55^2$
AM = 80.999 mm
AM = 81 mm.
Now, due to symmetry,
AM = MN = 81 mm
BM = AB – AM
BM = 162 – 81
BM= 81 mm
8) Height Calculation:
$Height^2 = BC^2 – NC^2$
$(162^2 – 115^2)^{1/2}$ = 114.101 mm
Net height = Height + Radius of wheel
=114.101 + 35
Net Height = 149.101 mm.
9) Track Width
= 2h
1.3 = 2 × 149.101
Tw = 387.66 mm.
TW = 387.66 mm

I. Advantages of Rocker Bogie Mechanism:

- Easy of operation.
- No spring is used.
- Gradual application of force prevents the chassis damage.
- Low manufacturing cost.
- No piston cylinder or fluid is used.
- 5000 Kg, push force, make possible suspensioning of heavy section possible.

J. Disadvantages of Rocker Bogie Mecahnism:

- Number of wires used.
- Turning mechanism is a complicated.

K. Application of Rocker Bogie Mechanism:

- Automobile industry.
- Army tankers.
- Agriculture equipment manufacture.
- Rough surface.
- Street climbing.
- Forest robots.
- Uneven surface.
- Wireless camera mounting.
- Material handling systems.

VI. CONCLUSION

This project will try reaching nearly all of our design requirements, and in many respects exceeding original design goals. Furthermore all components, mechanical and electrical, will be thoroughly tested as a completed system in real-world field testing conditions to validate their success. Overall, preliminary estimates for the general scope, budget, and timeline, for the project will be closely followed; with the exception if the project goes moderately over budget.The hodology as per the research it is find that the rocker bogie system reduces the motion by half compaired to other suspension systems because each of the bogie's six wheels has an independent mechanism for motion and in which the two front and two rear wheel have individual steering systems which allow the vehicles.

VII. FUTURE SCOPE:

As modular research platform the rover developed by this project is designed specifically to facilitate future work with the development in technology the rover can be used for reconnaissance purposes with the cameras installed on the rover and minimising the size of rover. With some developments like attaching arms to the rover it can be made useful for the Bomb Diffusing Squad such that it can be able to cut the wires for diffusing the bomb. By the development of a bigger model it can be used for transporting man and material through a rough terrain or obstacle containing regions like stairs. With the development in technology the rover can be used for reconnaissance purpose with the cameras installed on the rover and minimizing the size of rover. By the development of a bigger model it can be used for transporting man and material through a rough terrain or obstacle containg regions like stairs.

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