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Design and analysis of Rocker Bogie field Mobile Robot

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ABSTRACT

Rocker bogie mobile robot is being used in many terrain and was used in the mars pathfinder Mars Exploration Rover [MER] project India is facing a massive flood heavy down pour leading to huge flood damage and causing irreparable loss to life and property The motive of this paper is to understand mechanical design and its advantages of rocker – bogie suspension system in order to find suitability to implement it in post disaster management finally physical prototype of Rocker Bogie mobile robot is built which can claim staircase of height 150mm and length 350mm and tested in various conditions of surfaces including vertical obstacle, inclined surface and uneven terrain outdoor condition.

Keywords: Rocker bogie, Field mobile robot, Stair climbing.

INTRODUCTION

Over the past years, the rocker bogie mobile robot design has become a proven mobility application which is known for its superior vehicle stability, obstacle – climbing capability and stair-climbing capability It is well know that the rocker-bogie superstar was used in mars Exploration Rover (MER) project , the challenge in designing the rocker bogie suspension for Mar Exploration Rover project was to design a light weight a light weight rocker bogie suspension that would permit the mobility to show within the limited space available and into a configuration that the rover could then safely land the rover and explore the mars surface. We want a robot to be as simple as possible in most cases we never need a suspension system but there were most times when a suspension system but there were most times when a suspension system cannot be avoided. The term ‘’bogie’’ is a link that have a drive wheels in the end. Bogie were used as load wheels in the rocks of army tanks as idlers distributing the load over the terrain surface Bogie were also used on the trailers of semi-trailer lorries Both application prefer trailing arm suspensions. The rocker-bogie allows the rover to climb over obstacles, such as rocks, which are up to twice the wheels diameter in size while keeping all six wheels on the ground. The tilt stability depends upon the height of the centre of graving. India is a developing country which is located in located in South Asia surrounded by ocean on three sides. In every year Eastern states in India are hit by cyclones and western states are receives heavy rain from south west monsoon, which leads to raging river, massive flood and landslide in hilly areas. The normal transportation are of no use during this time. This situation creates a difficulty to task force while bringing aid during the post disaster management

LITERATURE REVIEW

The construct of our research work is to make a rocker bogie drive system based on those of NASA. The rocker-bogie suspension system hold all six wheels on the robot in uni contact with the ground even on even out surfaces. The rocker-bogie suspension mechanism which was currently

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NASA's approved design for wheeled mobile robots, mainly because it had study or bouncy capacity to trade with obstruction and because it uniform distributes the payload over its six wheels at all times. It also can be used for other purport to operate in rough roads and to climb the stairs. It was having lots of advantages but one of the major disadvantages is the rotation motion of the mechanism where and when is requirement. In this work the proposed steering mechanism was designed and the modelling was done in CREO (2.0) [1].

The researchers discuss the new concept and technical parameter design of a robust stair climbing compliant modular-robot, capable of tackle box stairs with over hangs. The robot prototype was shown to have success scaled stairs of varying dimensions, with overhang, thus corroborating the analysis performed [2].

An analysis method to create the rocker bogie mechanism can climb over a stair was achieved in the work. The east coast of Malaysia faced with massive flood from heavy downpour, leading to huge flood damage property. The research paper proposed an intelligent inclined motion control of a rocker bogie mechanism amphibious vehicle while moving on uneven terrain surface [3].

The research paper deals with the designing, modelling and analysing of stair climbing robot proposed on the well-known rocker bogie mechanism in ANSYS rigid body dynamics module. The robots usually suffer from undesired phenomenon slip, sticking and manoeuvring while climbing steps and stairs, which may cause instability of the robot [4].

The Taguchi method was tacked to chosen as an optimization tool to make trajectory of model of mass close to straight line while all wheels keep with the ground during climbing stairs. Taguchi method was adopted due to its simplicity and cost effectiveness both in formulating the objective function and satisfying multiple constraints simultaneously. Three variant shapes of typical stairs were selected as user concept to determine a Robust optimal solution. The result acquired shows the variant of centre of mass position in time, variation of velocity of joint with time and variation of force with time [5].

It was basic a suspension pattern used in mechanical robotic vehicles used specifically for space exploration. The rocker-bogie suspension based rovers has been success introduce for the mars pathfinder, mars exploration rover (MER) , mars science laboratory (MSL) missions conducted by apex space exploration agencies passim the world. The proposed suspension system was currently the most favoured design for every spacing exploration company with indulge in the business of space research. [6].

The world market of mobile robot was expected to the next 20 year, surpassing the marketing of industrial robot in terms of units and sales. The design of the locomotive systems of mobile robot for unstructured environment was generally complex, particularly when they were required to move on uneven or smooth terrains, or to climb obstacles [7].

This type of mechanism has been used on mostly of the rovers on Mars and has proved to be a easy and elegant design. A genetic algorithm was implemented and used to optimize the geometry and kinematics of the rover' shekel Suspension system subject to the defined performance metrics .This work shows the effectiveness of the optimization of a rocker-bogie suspension system using a Genetic Algorithm. It also reveals that the resulting system meets all design constraints and that significantly reduces the error of individual performance metrics and the All system. It was shown that the all fitness of the rover suspension system can be increment by an average of 28% after 100 iterations compared with an initial guess. All performance metrics defined were improved significantly throughout the optimization. The method can be applied to varies types of rovers in rural to optimist the wheel suspension mechanism's geometry [8].

PROBLEM IDENTIFICATION

The important problem associated with current suspension systems installed in heavy loading vehicles rovers (including those with active suspension and semi active suspension systems) is their slow speed of motion which cause to leave its tracks unknowingly the a strong regular repeated pattern of movement to absorb the shocks generated by wheels which remain the result of factors. First, in order to pass over obstacles like stone or wooden block the vehicle must be geared down significantly to allow for enough torque to raise the mass of the vehicle so, that it can climb the slope. Consequently, this reduces overall speed which cannot be permitted in the case of heavy loading vehicles. Second, if the vehicle is travelling at a high speed and unexpectedly be faced with an obstacle (height greater than 10 percent of wheel radius), there will be a large shock transmitted through the chassis which could damage the suspension or suddenly fall down the entire vehicle. This is why current heavy loading vehicles travel at a velocity of 0.1m/s through uneven terrain.

DESIGN OF ROCKER BOGIE

The first and foremost factor in manufacturing of rocker bogie mechanism is to find the angle between rocker and bogie linkages and its dimensions. Based on our requirements the angles and lengths can be changed. There we have to design and manufacture the rocker bogie mechanism which can over the obstacles of 150mm height (link wooden blocks, stones) and to climb the stairs of height 150mm and so another target is to climb any surface at an angle of 45^0 . To achieve the above target we had design the rocker- bogie model by assuming stair height 150mm and length 370mm. Using Pythagoras theorem, find the dimension of the model. It have both angles of linkages are 90.

Design calculation

The objective of the research work is to make the rocker bogie climbing robot stair . To achieve proper stair climbing the dimensions of linkages is the essential and should be proper. Assume the stair height and length 150mm and 370 mm respectively. To make it climb stairs with higher stability, it is required that only one pair of wheel should be in rising position at the movement. Hence to find lengths and angles of bogie linkages, first pair of wheels should be placed at horizontal position means at the starting point of the stair And second pair should be placed just before the start point of rising. There must be some distance between vertical edge of stair and second pair of wheel to striking of wheels. CREO drawing for first triangle Now, need to obtain the distance between first and second wheel through CREO software (190 mm).

Considering the right angled triangle ABC, Using Pythagoras in Δ ABC assume lengths A and BC is x.

$AC^2 = AB^2 + BC^2$

$190^2 = x^2 + x^2$

$190^2 = 2x^2$

x = 134 mm

Hence, AB = BC =134 mm CAD drawing for second triangle.

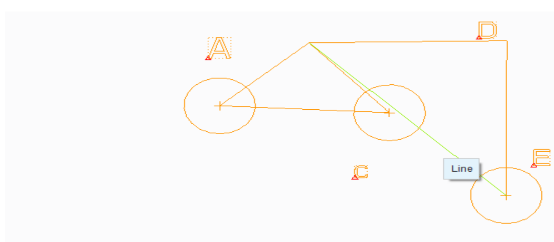

Fig. 1 CREO Drawing for Bogie

Same way we need to find dimensions for rocker linkages first two wheel pairs should be placed at horizontal position. Third wheel pair must nearly complete its rising before starting of rising of first pair of wheel. By placing the wheel in the required manner we obtained dimension of link BC (300mm).

Now consider ΔBDE

$BE^2 = BD^2 + DE^2$

$311^2 = 2y^2$

y = 221 mm

Hence, BD = DE = 221 mm.

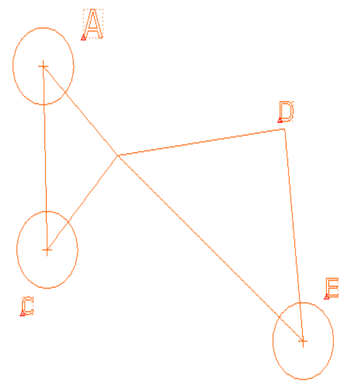

Fig. 2 CREO Drawing for Rocker

By considering all these lengths and angles we have drawn and built the whole mechanism. Shows all dimensions of robot.

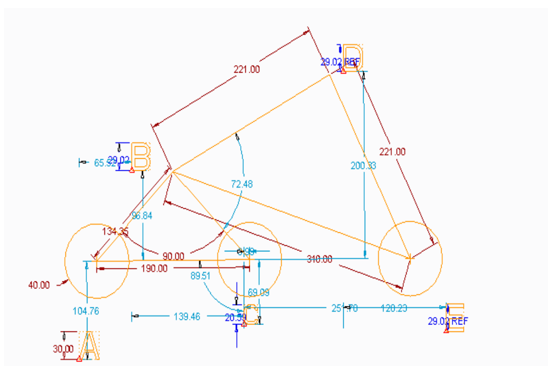

Fig. 3 CREO Drawing for Rocker and Bogie

Selection of Acceleration for Robot

Any robot on a flat surface or ground it need to take acceleration about half of maximum velocity. Let's say that the maximum velocity. Of robot is 0.5m/s then the acceleration of robot will be 0.5/2 means 0.25 $m/s^{2.}$ This indicates it would take 2 seconds to reach maximum speed of the robot. If the robot is going to climb up the inclined surface or through a rough Terrain you will need a higher acceleration to face the counter effect of countering gravity. We needed to climb the angle upto 450.

Acceleration of inclines

$=9.81 * \sin$ angle of inclination $* \pi/180$ (1)

= 0.121 m/s2

Total Acceleration = 0.25+0.121 = 0.371 m/s^2

CONCLUSION

In this paper we have shown how rocker bogie system will work on different surfaces. It depends on the different weight acting on link determines torque applied on it the rocker bogie can climb the stair with great stability the designed and fabricated model can move up the angle up to $45^{0.}$. During stair climbing test for length less than 300mm (15inch) system cannot climb the stair. It can be possible to develop new models of rocker bogie which can climb the stairs having low lengths if the dimensions are changed.

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