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Design and Fabrication of Rough Terrain Traversing Vehicle using Rocker Bogie Mechanism

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ABSTRACT: Rocker bogie is 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. A six wheeled rover capable of traversing rough terrain using an efficient high degree of mobility suspension system. The primary mechanical feature of the rocker bogie design is its drive train simplicity, which is accomplished by using only two motors for mobility. Both motors are located inside the body where thermal variation is kept to a minimum, increasing reliability and efficiency. Six wheels are used because there are few obstacles on natural terrain that require both front wheels of the rover to climb simultaneously. A series of mobility experiments in the agriculture land, rough roads, inclined, stairs and obstacles surfaces concluded that rocker bogie can achieve some distance traverses on field.

KEYWORDS: Rocker bogie; Wheel type mobile robot; Rover.

1. INTRODUCTION

There is an increasing need for mobile robots which are able to operate in unstructured environments with highly uneven terrain. these robots used for task which human cannot do and which are not safe. In order to achieve the tasks, any mobile robot needs to have a suitable mobile system according to each situation. Among these mobile system, it's the rocker bogie suspension system that was first used for the mars rover sojourner and its currently NASA's favored for rover wheels suspension. the rocker bogie suspension is a mechanism that enables a six-wheeled vehicle to passively keep all six wheel in a contact with surface even driving on severely uneven terrain. There are two key advantages to this feature. The first advantage is that the wheels pressure on the ground will be equilibrated. This is extremely important in soft terrain where excessive ground pressure can result in the vehicle sinking into the driving surface. the second advantage is that while climbing over hard, and event terrain, all six wheels will nominally remain in contact with the surface and under load, helping to propel the vehicle over the terrain. Exploration rovers take advantage this configuration by integrating each wheel with a drive actuator, maximizing the vehicles motive force capability. One of major shortcoming of current rocker – bogie rover is that they are slow. In order to able to overcome significantly rough terrain (i.e. obstacles more than a few percent of wheel radius) without significant risik of flipping the vehicle or damaging the suspension, these robots move slowly and climb over the obstacles by having wheel lift each piece of the suspension over the obstacles one portion at time. While performance on rough terrain obstacle is important, it should be also consider situation where the surface is flat or it has almost imperceptible obstacles, where the rover should increase its speed to arrive faster from A to point B. Rocker-bogie suspension system that was first used for the Mars Rover Sojoumer and it's currently NASA's favored design for rover wheel suspension. This is very less explored field of study and could be developed into exploration purpose instrument. The need to develop specialized high-fidelity systems capable of operating in harsh earth environment typically leads to longer development timelines and greater expenditures. while specific application will always require unique design, there are many commonalities in planetary rovers. Issues such as mobility, navigation and vision, many differ slightly between missions but are largely the same in all scenarios. Given these fundamental characteristics of many planetary rovers we believe that a modular and ruggedized system meeting these basic requirements would aid in the process of developing space ready technology. to operate harsh earth environment that are often used planetary surface rover testing. By creating a rover that is suitable these types of environments, our goal is to facilitate the development of rover and their related technologies. In addition to lowering development cost. We also hope that the platform developed can be tested and improve upon, to potentially serve as a model for a rover that could go to the moon or Mars.

Our mission to design, develop and test a rover serve as a research platform, suitable for testing planetary surface exploration technology in harsh earth environments. The design will focus on incorporating feature that is believed to

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be essential for most planetary exploration missions. The rocker bogie suspension system can be sent for reconnaissance purpose, which is exploring the surrounding to give visualization to a person or operating sitting somewhere for carrying the operations due to this feature of the rocker bogie suspension system this can be used in military for visualizing the scenario where the bomb is planted. Another idea is by using these mechanism design a wheel chair to take the patients from one place to another place climbing the stairs on its own. It can also be used for material delivery purposes. As explained this is a wide field of study and very less explored. So this gave the motivation for the development if this suspension system.

II. LITERATURE REVIEW

Recent rovers and their missions Much of space exploration can be divided into three categories: a quest to better understand our universe, interest, and economic potential in using natural resources outside our planet, and the future, colonization of extra-terrestrial bodies. Furthermore, most interest has been in our moon and mars. As these planetary bodies are close by, and have environments that are hospitable enough for rovers, and potentially for future colorization.

The moon is also very well suited for scientific equipment such as radio observatories or IR telescopes , as it has no atmosphere, instruments such as these can measure signals that would otherwise be disturbed or eliminated on earth. Interest in mars mostly relates to expanding our knowledge of the planet, specifically with respect to its ability to support a human colony. Learning more about the composition of its atmosphere and soil can tell us whether mars could potentially support microbial life.

Since 1976, NASA has been exploring the surface of mars with rovers, starting with the dual landing of Viking 1 and Viking 2 Landers. In 1997, the mars pathfinder (mpf) Lander delivered the sojourner rover to the surface successfully. Most recently, in early 2004, NASA again landed two more rovers on mars, spirit and opportunity. In November 2011, NASA has launched the mars science laboratory (msl) with a rover named curiosity. Despite the multiple rovers that NASA has sent to mars, each mission has similar objectives. Making improvements from past mars rovers, NASA has continued to develop autonomous navigation to make it easier and quicker to control their rovers, given the relatively large time delays in sending commands . to do this, on-board stereo vision processing was used to develop an image on the environment, which identified positive and negative obstacles relative to the ground plane. The other main features of MERs relate to mobility hardware, which allowed them to traverse the Martian terrain with relative ease. In continuation of past mars rover design, the rocker-bogie suspension was used. It consists of six wheels and multiple axles that allow the rover to overcome obstacles larger than its wheel diameter. The specialized wheels of the rover are approximately 26 centimeters in diameter and have a unique aluminum flexure structure to connect the hub to the rim of the wheel. These flexure joints act as shock absorbers which help to reduce the shock loads on other components of the rover. Each wheel also has small cleats, which have been found to be effective both for soft sandy terrain and in navigating over rocks.

Curiosity an advantage in terms of its path lining ability. It has a three axis inertial measurement unit (IMU) , enabling the rover to make precise movements while also monitoring the degree of tilt that the rover is experiencing. To tackler the mobility challenge, the 900kg rover has a very similar 6 wheel rocker-bogie suspension as previous mars exploration rovers have. The larger size combined with the rocker-bogie suspension allows the rover to go over obstacles 60-75 cm higher, which is greater than its wheel diameter of 50 cm. it can also safety, curiosity also has created treads that are similar to the MER rovers, which were found to be an optimal solution for Martian terrain. With a top speed of 4cm/sec, it was the fastest rover sent to mars.

In reviewing NASA's rovers for surface exploration on mars, there were many similarities in both their mechanical design and software that enable the rovers to perform on-board path planning. Autonomous planetary navigation combined with hazard avoidance and other self-preservation autonomy makes these rovers excellent platforms to reliably transport and position their scientific instruments. The biggest changes between missions have been the size of the rover and the types of scientific instruments it supports.

Astrobotic technology inc. is one such company that has founded itself on making space exploration profitable, by delivering payloads and performing robotic services on the moon. They are currently in collaboration with Camegie

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Mellon University and others, to develop a rover and lander for their first surface lunar exploration mission, which it successful will satisfy the X-prize criteria as well as other objectives. Their robot, called red rover, is reviewed here because it is one of the most developed lunar exploration rovers. Red rover is designed to be a scout, exploring places such as polar ice fields or skylights into lunar lava tubes. Its goal is to determine where the interesting locations are based on its analysis of chemical composition and high resolution 3D IMAGES.

6The proposed paper produces a novel design in pursue of increasing the rocker-bogie mobility system in conventional heavy loading vehicle behavior when high-speed traversal is required.The proposed modification increases in the stability margin and proved with valuable and profitable contrasting with the 3D model simulations done in SOLIDWORKS. In future, if the system installed in heavy vehicles and conventional off road vehicles, it will definitely decreases the complexity as well as power requirements to retain bumping within it Future scopes of Rocker Bogie Mechanism are in military operations as a weapon carrier & for locating coal deposits in coal mines.

This paper discusses the concept and parameter design of a Robust Stair Climbing Compliant Modular Robot, capable of tackling stairs with overhangs. Modifying the geometry of the periphery of the wheels of our robot helps in tackling overhangs. Along with establishing a concept design, robust design parameters are set to minimize performance variation. The Grey-based Taguchi Method is adopted for providing an optimal setting for the design parameters of the robot. The robot prototype is shown to have successfully scaled stairs of varying dimensions, with overhang, thus corroborating the analysis performed.

8This work shows how rocker bogie system works on different surfaces. As per the different weight acting on link determines torque applied on it. By assuming accurate stair dimensions, accurately dimensioned rocker bogie can climb the stair with great stability. The design and manufactured model can climb the angle up to 45˚. Also we tested for the Web cam with AV recording mounted on rocker bogie system and found satisfactorily performance obtains during this test wheels are rotated around 360˚. During stair climbing test for length less than 375 mm (15 inch) system cannot climb the stair. It can be possible to develop new models of rocker bogie which can climb the stairs having low lengths.

III. DESIGN OF ROCKER BOGIE

The important factor in manufacturing of rocker bogie mechanism is to determine the dimensions of rocker and bogie linkages and angles between them. The lengths and angles of this mechanism can be changed as per requirement. The aim of this work is to manufacture the rocker bogie mechanism which can overcome the obstacles of 150 mm height (like stones, wooden blocks) and can climb over stairs of height 150 mm. Also another target is to climb any surface at an angle of 45˚.

To achieve the above targets we had designed the rocker-bogie model by assuming stair height 150 mm and length 370 mm. Using Pythagoras theorem, we found the dimensions of the model. It have both angles of linkages are 900 and 450. A. Design calculation The objective of the research work is stair climbing. To achieve proper stair climbing the dimensions of linkages should be proper.
Assume the stair height and length 150 mm and 370 mm respectively. To climb stairs with higher stability, it is required that only one pair of wheel should be in rising position at a time. Hence to find dimension of bogie linkages, first pair of wheels should be placed at horizontal position means at the end of the rising as shown in Fig.1. And second pair should be placed just before the start of rising. There should be some distance between vertical edge of stair and second pair of wheel to striking of wheels.The following fig. 1,2.

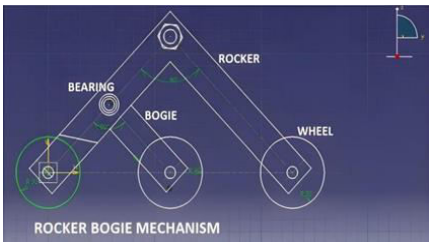

Fig.1- 2D Sketch

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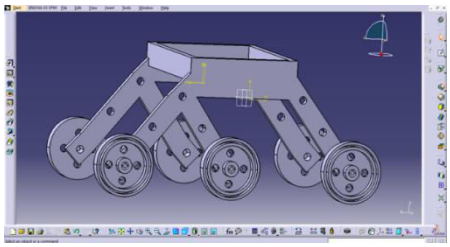

Fig.2- Final Assembly

IV. FABRICATION

The fabrication process, which includes drilling, welding, cutting and grinding, was the primary emphasis of this project. These techniques are crucial for forming and putting together materials especially metals for a range of structural and mechanical uses. While welding produces robust, long-lasting couplings between components, drilling guarantees accurate holes for bolts or connections. Cutting enables precise material separation or shaping, while grinding aids in surface finish refinement or dimension adjustment. These procedures work together as the foundation of fabrication, guaranteeing the end product's quality and structural integrity. This following fig.3-showcase this project.

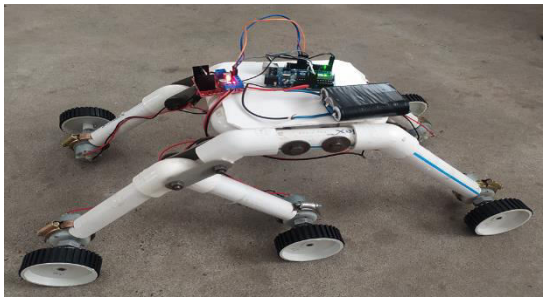

Fig.3-Rough Terrain Vehicle

V. 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 minimizing the size of the 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. We could develop it into a wheel chair too. It can be send in valleys, jungles or such places where humans may face some danger. It can also be developed into low cost exploration rover that could be send for collecting information about the environment of some celestial bodies.

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 goals moderately over budget.

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[9] Vol-3 Issue-3 2017 IJARIIE-ISSN(O)-2395-4396 5476 www.ijariie.com 2206 "ROCKER BOGIE SUSPENSION SYSTEM" Kevalaji Mane1, Ashok Ibitwar 2 , Sadanand Sonwane3, Dnyaneshwar Pitale 4 , Prof. Ajay.8

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