Experimental Analysis of climbing stairs with the rocker-bogie mechanism

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ABSTRACT

An analysis method to make the rocker bogie mechanism can climb up a stair is achieved in this paper. the east coast of Malaysia faced a massive flood from heavy downpour, leading to huge flood damage and caused irreparable loss to life and property. The flood carries the debris, soil and trees along their path, damaging the road and building structure, leaving the road become uneven. This situation gives difficulty to task force bearing aids during the post disaster management. This paper proposed an intelligent inclined motion control of an amphibious vehicle while moving on uneven terrain surface.

KEYWORDS ;*Rocker bogie; Wheel type mobile robot; Stair climbing; Kinematic analysis*

1.INTRODUCTION

The place, where the value of gravity remain lower than earth's own gravitational coefficient, at that place the existing suspension system fails to fulfil desired results as the amount and mode of shock absorbing changes. To counter anti gravity impact, NASA and Jet Propulsion Laboratory have jointly developed a suspension system called the rocker-bogie Suspension system. It is basically a suspension arrangement used in mechanical robotic vehicles used specifically for space exploration. The rocker-bogie suspension based rovers has been successfully introduced for the Mars Pathfinder and Mars Exploration Rover (MER) and Mars Science Laboratory (MSL) missions conducted by apex space exploration agencies throughout the world. The proposed suspension system is currently the most favoured design for every space exploration company indulge in the business of space research. The motive of this research initiation is to understand 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.

The rocker-bogie design has no springs or stub axles for each wheel, allowing the rover to climb over obstacles, such as rocks, that are up to twice the wheel's diameter in size while keeping all six wheels on the ground. As with any suspension system, the tilt stability is limited by the height of the center of gravity. Systems using s prings 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 45 degrees in any direction without overturning, but automatic sensors limit the rover from exceeding 30-degree tilts.[5] The system is designed to be used at slow speed of around 10 centimeters per second (3.9 in/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 vehicle up and over the obstacle. The middle wheel is then pressed against the obstacle by the rear wheels and pulled against the obstacle by the front until it is lifted up and over. Finally, the rear wheel is pulled over the obstacle by the front two wheels. During each wheel's traversal of the obstacle, forward progress of the vehicle is slowed or completely halted. This is not an issue for the operational speeds at which these vehicles have been operated to date.

One of the future applications of rovers will be to assist astronauts during surface operations. To be a useful assistant, the rover will need to be able to move much faster than human walking speed or at least equivalent. Other missions which have been proposed, such as the Sun-Synchronous Lunar Rover, require even greater speeds (4–10 km/h).

2. LITERATURE REVIEW

***Nitin Yadav at**. Al*.[1]The place, where the value of gravity remain lower than earth's own gravitational coefficient, at that place the existing suspension system fails to fulfil desired results as the amount and mode of shock absorbing changes. To counter anti gravity impact, NASA and Jet Propulsion Laboratory have jointly developed a suspension system called the rocker-bogie Suspension system. It is basically a suspension arrangement used in mechanical robotic vehicles used specifically for space exploration. The rocker-bogie suspension based rovers has been successfully introduced for the Mars Pathfinder and Mars Exploration Rover (MER) and Mars Science Laboratory (MSL) missions conducted by apex space exploration agencies throughout the world. The proposed suspension system is currently the most favoured design for every space exploration company indulge in the business of space research. The motive of this research initiation is to understand 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.
Dongkyu Choi at.al [2] To verify whether the rocker bogie, with certain lengths of the linkages and radii of the wheels, could climb up a target stair or not, a kinematic analysis and its posture are determined. The trace of the center of mass of the rocker bogie was considered and the situation that three wheels contact the front side of the stair is analyzed. With this two analyses, the stair climbability graph (SCG) determined with the length and the height of a stair was drawn.

Hong-an Yang at.al [3] The rocker-bogie suspension mechanism it's currently NASA's favored design for wheeled mobile robots, mainly because it has robust capabilities to deal with obstacles and because it uniformly distributes the payload over its 6 wheels at all times. Even though it has many advantages when dealing with obstacles, there is one major shortcoming which is its low average speed of operation, making the rocker-bogie system not suitable for situations where high-speed traversal over hard-flat surfaces is needed to cover large areas in short periods of time, mainly due to stability problems. This paper proposes to increase the stability of the rocker-bogie system by expanding its support polygon, making it more stable and adaptable while moving at high speed, but keeping its original robustness against obstacles: One rocker-bogie system, two modes of operation.

Brian D. Harrington and Chris Voorhees [4] Over the past decade, the rocker-bogie suspension design has become a proven mobility application known for its superior vehicle stability and obstacle-climbing capability. Following several technology and research rover implementations, the system was successfully flown as part of Mars Pathfinder's Sojourner rover. When the Mars Exploration Rover (MER) Project was first proposed, the use of a rocker-bogie suspension was the obvious choice due to its extensive heritage. The challenge posed by MER was to design a lightweight rocker-bogie suspension that would permit the mobility to stow within the limited space available and deploy into a configuration that the rover could then safely use to egress from the lander and explore the Martian surface. This paper will describe how the MER rocker-bogie suspension subsystem was able to meet these conflicting design requirements while highlighting the variety of deployment and latch mechanisms employed in the design.

3. PROBLEM IDENTIFICATION

- A The main problem associated with current suspension systems installed in heavy loading vehicles rovers (including those with active and semi active suspension systems) is their slow speed of motion which derail the rythem to absorb the shocks generated by wheels which remain the result of two factors.
- First, in order to pass over obstacles the vehicle must be geared down significantly to allow for enough torque to raise the mass of the vehicle. Consequently, this reduces overall speed which cannot be tolerated in the case of heavy loading vehicles.

- Second, if the vehicle is travelling at a high speed and encounters 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 tapple down the entire vehicle. That is why current heavy loading vehicles travel at a velocity of 10cm/s through uneven terrain.
- The software based testing of rocker bogie suspension system describes the momentum and efficiency related utilities in cumulative manner.

4. METHODOLOGY

The methodology for this project is similar to the fabrication analysis process. In this project we are fabricating air pre-heater and other experimental attachments. The methodologies of these attachments are explained in few sub- headings.

4.1. geometry of rocker bogie

4.2. Working of system

The methodology is explained in four parts. System parts are given with their specification and dimension. Modeling will have a simple layout type diagram in thesis. In this diagram the parts are explained by their major dimensions only. Working has just functional details in paragraphs. The delayed or incomplete portion of fabrication is not explained. These portions are explained by topic "improvements and modification".

4.1. Geometry of rocker bogie

As per the research it is find that the rocker bogie system reduces the motion by half compared 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 wheels have individual steering systems which allow the vehicle to turn in place as 0 degree turning ratio. Every wheel also has thick cleats which provides grip for climbing in soft sand and scrambling over rocks with ease. In order to overcome vertical obstacle faces, the front wheels are forced against the obstacle by the centre and rear wheels which generate maximum required torque. The rotation of the front wheel then lifts the front of the vehicle up and over the obstacle and obstacle overtaken. Those wheels which remain in the middle, is then pressed against the obstacle by the rear wheels and pulled against the obstacle by the front till the time it is lifted up and over. At last, the rear wheel is pulled over the obstacle by the front two wheels due to applying pull force. During each wheel's traversal of the obstacle, forward progress of the vehicle is slowed or completely halted which finally maintain vehicles centre of gravity. The above said methodology is being practically proved by implementing it on eight wheel drive ATV system in order to gain maximum advantage by rocker bogie system.

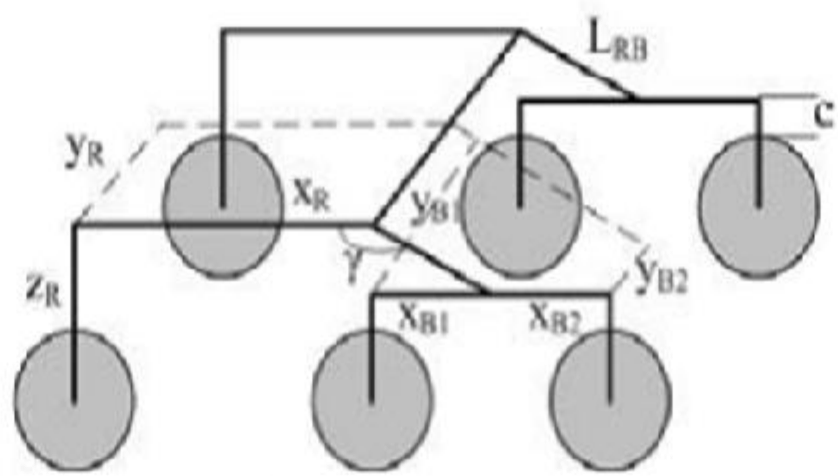

Fig. Geometry of rocker bogie

4.2. Working of system

The high pressure gas exiting the cylinder initially flows in the form of a "wave front" as all disturbances in fluids do. The exhaust gas pushes its way into the pipe which is already occupied by gas from previous cycles, pushing that gas ahead and causing a wave front. Once the gas flow itself stops, the wave continues on by passing the energy to the next gas downstream and so on to the end of the pipe. If this wave encounters any change in cross section or temperature it will reflect a portion of its strength in the opposite direction of its travel. The basic principle is described in wave dynamics. A heat chamber makes use of this phenomenon by varying its diameter (cross section) and length to cause these reflections to arrive back in the cylinder at the desired time in the cycle. An approximation of a heat chamber in operation. It does a good job illustrating the positive portion of the exhaust pulse, however, there are several errors in this animation: The exhaust would not go all the way through the pipe in the 1 cycle. Neither does it show the suction wave generated by the diverging section. The fresh mixture drawn into the header pipe cannot go all the way down the header pipe

5. RESULT AND DISCUSSION

In this paper, we will focus the relation the distance between centres of a body towards the terrain surface. The vehicle will have two configurations which are the rocker-bogie mechanism is retracted and deployed. We were using an equation 1 to equation 4 to calculate the vehicle's angle. The Lcd is a distance of front wheel towards the vehicle's centre and Lcc is a distance between the rear wheel and vehicle's centre. The zc is a distance of vehicle's centre towards the ground surface while bc is a distance of wheel to the centre at the front view. The Lcd and zc values changes will affect the angle of front-hill Gradeability while Lcc and zc contributing changes for downhill Gradeability. The crosshill Gradeability affected by the changes of zc only since the bc is a distance of wheel toward vehicle's centre remain unchanged. The values of zc give major effect since lowering the centre of a vehicle is increasing the vehicle stability

6. CONCLUSIONS

An analysis of the conditions for the rocker bogies to climb up stairs was discussed in this paper. With certain lengths of the linkages and radii of the wheels, a kinematic analysis was performed when the rocker bogies climbs up the stairs. The center of mass of the rocker bogies was considered and the situation where three wheels simultaneously contact the front sides of the stair was analyzed. By using two analyses, the possibility of climbing up the stair was determined with the lengths and heights. By extending and generalizing the analysis to the lengths and heights of the stairs available in everyday life, the stair climbability graph (SCG) can be drawn. The prototypes of the two rocker bogies which have different lengths of the linkage were designed and tested on two different stairs. As has been reiterated from the result of the analysis, the small rocker bogie could overcome the stair with a length of 450 mm and a height of 150 mm but could not overcome the stair with a length of 300 mm and a height of 175 mm. On the other hand, the large rocker bogie could overcome both stairs. Therefore, the analysis in this paper enables an operator to determine a rocker bogie's possibility of overcoming a stair with a given length of its linkage and the radius of the wheel. If the target stair is marked as red in the SPG, the rocker bogie could climb up the stair by changing its lengths of the linkages that make a blue dot in SCG.

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