“ROCKER BOGIE MECHANISM”

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Abstract

The place, where the value of gravity remains 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 favored design for every space exploration company indulge in the business of space research.

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 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 45 degrees in any direction without overturning, but automatic sensors limit the rover from exceeding 30-degree tilts. 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.

The rocker-bogie suspension is a mechanism that, along with a differential, enables a six-wheeledvehicle to passively keep all six wheels in contact with a surface even when 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, uneven 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 of this configuration by integrating each wheel

with a drive actuator, maximizing the vehicle's motive force capability. 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.

One of the major shortcomings of current rocker-bogie rovers is that they are slow. In order to beable to overcome significantly rough terrain (i.e., obstacles more than a few percent of wheel radius) without significant risk of flipping the vehicle or damaging the suspension, these robots move slowly and climb over the obstacles by having wheels lift each piece of the suspension over the obstacle one portion at a time. While performance on rough terrain obstacles is important, it should be also considered situations where the surface is flat or it has almost imperceptible obstacles, where the rover should increase its speed to arrive faster from point A to point B.

In our project, we have focused over eight wheeled rocker-bogie suspension system design which has advantage of linear bogie motion in protecting the whole system from getting rollovers during high speed operations. This has greatly increased the reliability of structure on rough terrains and also enables its higher speed exploration with same obstacle height capacity as twice the diameter of wheel.Several simulations were done over **Solidworks** and **Ansys**which has left us with crucial data and visualization that nearly approximates towards our aim.

To test the stability and high speed of the eight-wheeled rocker bogie mechanism we conducted several simulations over Solidworks, comparing the six-wheeled and the eight-wheeled mechanism over the test path consisting of various obstacles of different heights and gradients. To our surprise, we found that at the high speeds comparable to that of conventional off road vehicles (30 km/hrs.), the six-wheeled mechanism after travelling to a certain distance and crossing few obstacles, faced a rollover which was very clear from its Center of Mass Vs Time plot. On the other hand, the eight-wheeled mechanism did not face the problem of rollover at any place across the path, and crossed all the obstacles smoothly in one go. The Center of Mass Vs Time plot also corresponded the act with slight variations in its position in Y direction. This showed and confirmed that the eight-wheeled rocker bogie mechanism has more stability while moving at high speeds, tackling the obstacles.

To find the critical areas of the design we did an analysis over Ansys software by applying a load over the free shaft (load of the chassis). The analysis of Stress, Strain, and Deformation clearly showed the critical areas of the design and this would help in its real construction as it would be well known before, from where the mechanism would fail.

				
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