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Study of Rocker Bogie Suspension System with Spherical Wheels & its application on Vehicle Chassis

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***Abstract*— Having done a case study on Rocker Bogie Suspension System in the view of using it in harsh terrain and rough geographical conditions where any conventional vehicle suspension system fails, robotic rovers are being used extensively for exploratory purposes in the fields of scientific exploration and defense and we are of the view that it can be put to use in day to day life. We have also done a case study on Spherical Wheels, whose advantage which offers rigidity, robustness, non-invertible while travelling over rough surfaces. This is an excellent upgrade to the conventional wheels as it solves numerous problems faced by conventional wheels. So we are working on a prototype model integrating these two systems, we have already designed a 3D model using SOLIDWORKS. We plan to stabilize it and make it suitable for handling various problems as it'll provide greater maneuverability along with omnidirectional movement and we view it as a potential replacement to the conventional chassis system in vehicles.**

Keywords—Rocker Bogie; Suspension; Terrain; Spherical Wheel; Conventional; Omnidirectional; Maneuverability; Virtual prototype

I. INTRODUCTION

The Rocker Bogie suspension system, which is used in 'Rover' specifically designed for space exploration have deep history embedded in its development as stated by D. S. Chinchkar, R. N. Panchal [1]. The term "rocker" describes the rocking aspect of the larger links present on each side of the suspension system, these rockers are connected to each other and the vehicle chassis through a differential. And the bogie is the smaller part which is connected to the rocker at the middle and the ends are connected to the wheels. The chassis plays a vital role to maintain the average pitch angle of both rockers as it allows both rockers to move as per the terrain. Performing acute calculations the design is made such that, one end of the rocker is fitted with a drive wheel and the other end is pivoted to the bogie which provides required motion and excellent degree of freedom.

Nitin Yadav, BalRam Bhardwaj, Suresh Bhardwaj [2] stated that robotic rovers based on the rocker bogie suspension system has been successfully implemented in the Mars Pathfinder, Mars Exploration Rover (MER) for Mars Science Laboratory (MSL) which conducts missions for apex space exploration agencies throughout the World. This mechanism allows the vehicle to climb over high obstacles twice the size of its wheels with all of its wheels in contact with the ground which is not seen in the conventional suspension system which uses springs, struts, etc.

Spherical Wheel may be the most preferred type of wheels as it has advantages in aspect such as maneuverability, omnidirectional movement and also due to its holonomic nature. And as such the spherical wheels can navigate around any object easily and its chances of getting stuck in corners are reduced. Due to its shape there are no problems of overturning which is often the case in traditional wheels. This feature also allows them drop itself from height. Obstacles such as stairs and ledges can be tackled at ease which is not easy for wheeled or tracked bogies. These features enables it for operation in snow, mud and if sealed properly, even in water too. These advantages suggest that a spherical wheel would be appropriate for various applications. Even though a number of concept models have been deployed as a result of various researches in this particular field, but only a few have been successful.

II. DESIGN PROSPECT

Rocker-bogie suspension system has proved itself as an useful asset, as stated by Aditya V. [3] in the various exploratory and reconnaissance purposes as aforementioned and proving its usefulness in combating rough terrain and rigorous geographical conditions, it can be put to work as vehicular suspension system replacing the current conventional system consisting of shock absorbers, springs, struts, etc. The motive of this research initiation is to understand the mechanical design and advantages of rocker-bogie suspension system in order to find suitability to implement it in conventional vehicles to enhance their efficiency and also to cut down the maintenance related expenses of conventional suspension systems. Combining it with spherical wheels it forms an excellent vehicle chassis. Spherical wheels provide excellent maneuverability and Omni-directional movement.

While designing the system we've gone through various situations and come up with numerous ideas. But the efficient and workable design we've come with includes the rocker bogie system with 6-wheel spherical drive. The spherical wheels are housed in a casing using 3 supports consisting of small idle rollers which are coupled with the spherical wheels but are free to rotate about their axis, giving adequate support and ease of movement. The Driving mechanism consists of a motor supplying power to a roller which is frictionally coupled with the spherical wheel. The Steering mechanism we consider has a bevel gear powered by another motor. The output shaft of the bevel gear controls the steering movement of the roller which ultimately controls the wheels.

Friction between the spherical wheels and the driving roller is an important factor, so we plan to use a high frictional material (likes of synthetic rubber with additives) for fabricating the wheels and rollers. The material we are considering for the rocker bogie suspension system is Mild Steel which provides excellent strength including great tensile strength and is also very tough and adequate for any vehicular chassis.

III. FIGURES

Fig. 1. Spherical Wheels

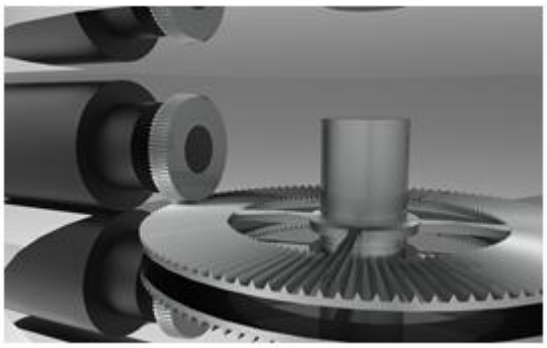

Fig. 2. Driving Mechanism

Fig. 3. Steering Mechanism & Wheel Casing

Fig. 4. 3D Model Prototype

IV. CONCLUSION

Through our study we've found out that our idea of Rocker Bogie Suspension System along with integrated Spherical Wheels can be a very useful asset in revolutionizing the vehicular suspension system as seen stated by Y. L. Maske, S. V. Patil, S. Deshmukh [4]. Our vision of an efficient, safe, capable suspension system with integrated omnidirectional wheels on future vehicles can be achieved through this study. It has major advantages over the conventional suspension system and also great maneuverability, omnidirectional, holonomic movements stated by Deepak Pokhrel, Nutan Raj Luitel, Sukanta Das [5]. The motion is such that it maintains the center of gravity of entire vehicle.

The Rocker Bogie suspension system is currently the most favored design for every space exploration research program. Also spherical wheels provide excellent maneuverability and omnidirectional movement. Problems like parking, holonomic movement, slipping in mud or sand, etc. can be easily tackled using it. This enables it for operation in snow, mud and if sealed properly, even in water also. These advantages indicate that this modified suspension system integrated with spherical wheel would be appropriate for many different applications such as surveillance, reconnaissance, hazardous environment assessment, search and rescue for military & defence. In planetary exploration, space research programs as well in commercial and extreme sports vehicles. This is economically as well as physically more efficient.

Also it'll tackle many unwanted, rough, tough geographical situations with ease. Hence we'll be building a working small scale prototype and hopefully after some modifications in the near future our fully functional idea will be brought to life replacing the current vehicular suspension system.

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