# Solar Based Rocker-Bogie Mechanism

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***Abstract*— This paper presents an innovative locomotion concept of six wheel based "Solar Rocker-Bogie Mechanism". The rocker-bogie suspension mechanism is currently NASA's favoured design for 4 wheel mobile robots, mainly because it has robust capabilities to deal with the 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 period of time, mainly due to stability problems. Our purpose is 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. The rocker-bogie mobility system was designed to be used at slow speeds. It is capable of overcoming obstacles that are on the order of the size of a wheel. However, when surmounting a sizing obstacle, the vehicles motion effectively stops while the front wheel climbs the obstacle. When operating at low speeds dynamic shocks are minimized when this happens. For many future planetary missions, rovers will have to operate at human level speeds. Shocks resulting from the impact of the front wheel against an obstacle could damage the payload or the vehicle. We will develop a method of driving a rocker-bogie vehicle so that it can effectively step over most obstacles rather than impacting and climbing over them. Most of the benefits of this method can be achieved without any mechanical modification to existing design – only a change in control strategy. Some mechanical changes are suggested to gather the maximum benefits and to greatly increase the effective operational speed of future rovers.**

***Keywords*—** Rocker-bogie, Stair climbing Rover, Wheel type mobile robot.

## I. INTRODUCTION

Rocker bogie is a six wheeled vehicle which runs on motor, this rover is capable to move on terrain surfaces and to overcome obstacles. It is provided with six wheels which are supported by each other while overcoming obstacles. The 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 centre of gravity. Systems using springs tend to tip more easily as the loaded side yields. This rocker bogie system reduces the motionof the main Mars Exploration Rover (MER) vehicle body by half compared to other suspension systems. Each of the rover's six wheels has an independent motor. The two front and two rear wheels have individual steering motors which allow the vehicle to turn in place. Each wheel also has cleats, providing grip for climbing in soft sand and scrambling over rocks. The maximum speed of the robots operated in this way is limited to eliminate as many dynamic effects as possible so that the motors can be geared down, thus enabling each wheel to individually lift a large portion of the entire vehicle. The term "rocker" comes from the rocking aspect of the larger links on each side of the suspension system. These rockers are connected to each other and the vehicle chassis through a differential. Relative to the chassis, when one rocker goes up, the other goes down. The chassis maintains the average pitch angle of both rockers. One end of a rocker is fitted with a drive wheel and the other end is pivoted to a bogie. The term "bogie" refers to the links that have a drive wheel at each end. Bogies were commonly used as load wheels in the tracks of army tanks as idlers distributing the load overthe terrain. Bogies were also quite commonly used on the trailers of semi-trailer trucks. Both applications now prefer trailing arm suspensions. Based on the centre 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 centimetres 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 centre 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.

## II. LITERATURE REVIEW

S. F. Toha and Zakariya Zainol researched on a amphibious vehicle during the massive floods in Malaysia in December 2014. This paper contains study of the amphibious vehicle based on rocker bogie mechanism which can be operated in both water and land (terrain surface), that can be used by task force for carrying aids to the needy [1].MongkolThianwiboon and ViboonSangveraphunsiri conducted a research on the method to estimate the wheel-ground contact angle and kinematics modeling of a six-wheel Rocker-Bogie robot. A traction control is proposed and integrated with the model then examined by simulation [2]. Jun Yung et. al introduced the different rocker bogie suspensions designed by different countries and demonstrate their capability to improve the performance of the suspensions. Various technologies with different configuration, component combination and mechanical designs are used to improve the performance of the suspensions which are also discussed in this paper [3]. Shumei Wu et. Al investigated the traction coordinating control issues of the wheeled lunar rover with Rocker Bogie in rough terrain by considering the slip [4]. Roland Siegwart et. al invented an innovative locomotion concept for rough terrain based on six motorized wheels by using rhombus configuration [5]. Richard Volpe et. al provided with information on a system overview of Rocky 2' and gives details on each of the advances it includes. It also describes the specification and construction of the rover prototype [6]. Thomas Thueer et. al invented a tool called Performance Optimization Tool (POT), for performance comparison of rough-terrain robots in simulation and

hardware [7].Pierre Lamon and Roland Siegwart proposed a solution for wheel-ground contact angles measurement and a global control strategy minimizing wheel slip in rough terrain. The simulations show clearly the advantages of torque control versus speed control. Dongkyu Choi et. al presented a new mobile platform named "Rocker-Pillar" which enables a robot to overcome rough terrains with stability. The robot is composed of two sets of caterpillar tracks, four wheels, and a pair of two linkages.

## PROBLEM STATEMENT

- According to the literature survey we found that the battery consumption of rover is more and also charging of those batteries is a limitation. To avoid this problem solar panel can be induced on the project.
- The speed of rovers is comparatively slow which can be increased by implementing the idea of separate motor for each wheel.
- The rovers are only capable to move on terrain surface or avoid obstacles, but it can be enhanced for stair climbing.

By considering all these point we have an idea of making a Solar based Rocker-Bogie Mechanism which can overcome all points considered in problem statement and can also used for stair climbing purpose.

## CAD MODEL

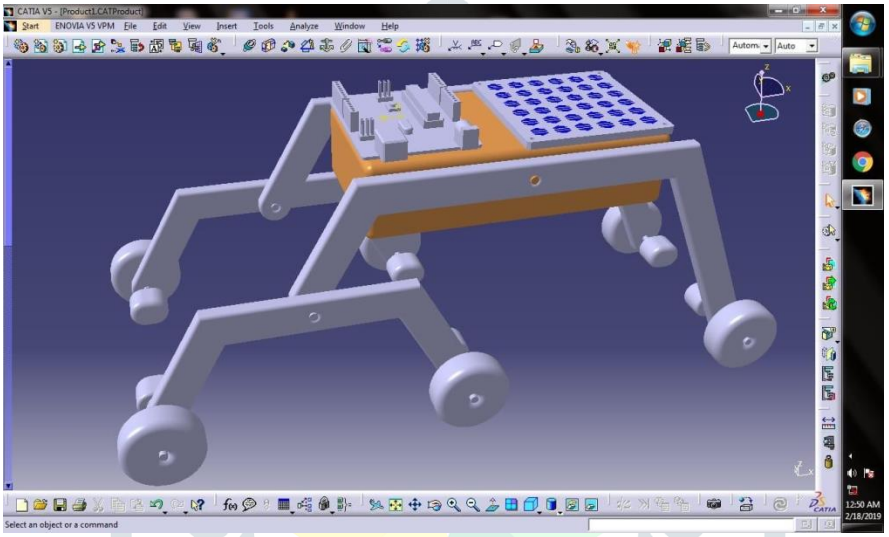

Fig. 1 Shows the 3D model of Solar based rocker-bogie mechanism

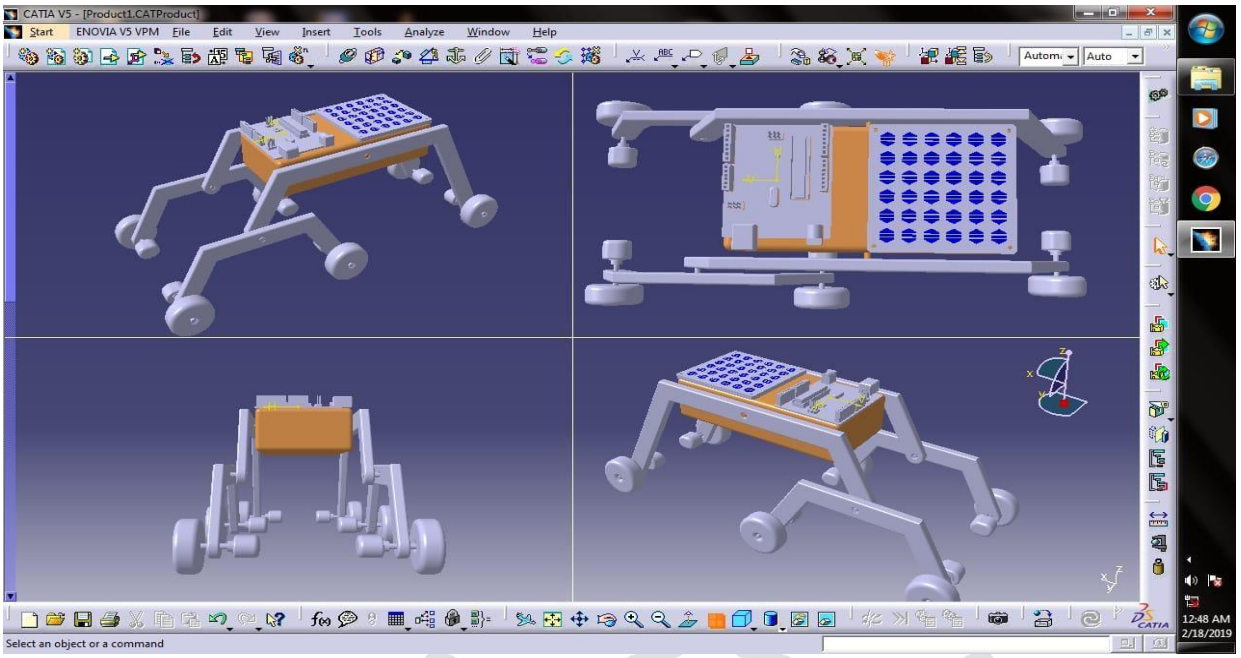


Fig. 2 Shows all views of CAD model

## III. CONSTRUCTION AND WORKING OF THE MODEL

### *A. Rocker and bogie link*

The term "rocker" comes from the rocking aspect of the larger links on each side of the suspension system. These rockers are connected to each other and the vehicle chassis through a differential. Relative to the chassis, when one rocker goes up, the other goes down. The chassis maintains the average pitch angle of both rockers. One end of a rocker is fitted with a drive wheel and the other end is pivoted to a bogie.

The term "bogie" refers to the links that have a drive wheel at each end. Bogies were commonly used as load wheels in the tracks of army tanks as idlers distributing the load over the terrain. Bogies were also quite commonly used on the trailers of semi-trailer trucks. Both applications now prefer trailing arm suspensions.

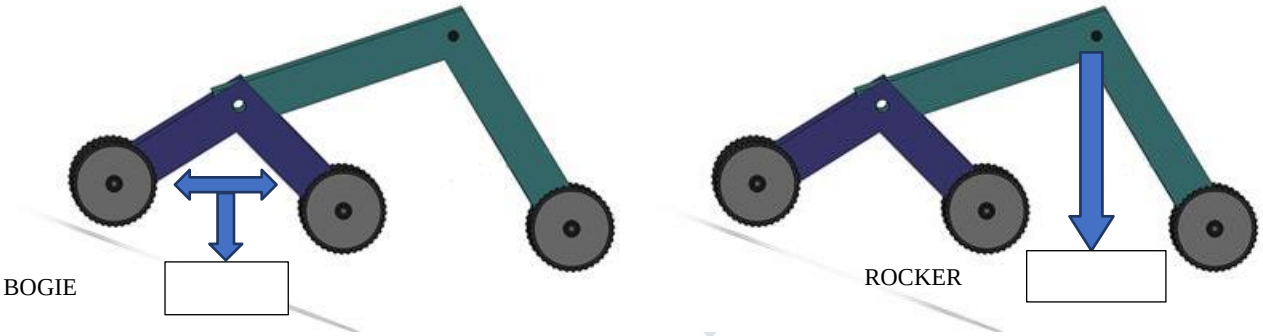


Fig. 3 Shows Rocker and Bogie

### *B. Wheels and Batteries*

Each of the rover's six wheels has an independent motor. The two front and two rear wheels have individual steering motors which allow the vehicle to turn in place. Each wheel also has cleats, providing grip for climbing in soft sand and scrambling over rocks. The maximum speed of the robots operated in this way is limited to eliminate as many dynamic effects as possible so that the motors can be geared down, thus enabling each wheel to individually lift a large portion of the entire vehicle's mass. The wheels structure of cleats which are used to slip at the time of climbing stairs and at rough terrain. These cleats control the slip ratio of the mechanism.

A 12volt battery is a rechargeable battery that supplies electrical current to a motor vehicle. Its main purpose is to feed the starter, which starts the engine. Once the engine is running, power for the car's electrical systems is supplied by the alternator. Typically, the starting discharges less than three percent of the battery capacity. For this reason, automotive batteries are designed to deliver maximum current for a short period of time. They are sometimes referred to as "SLI batteries" for this reason, for Starting, Lighting and Ignition.

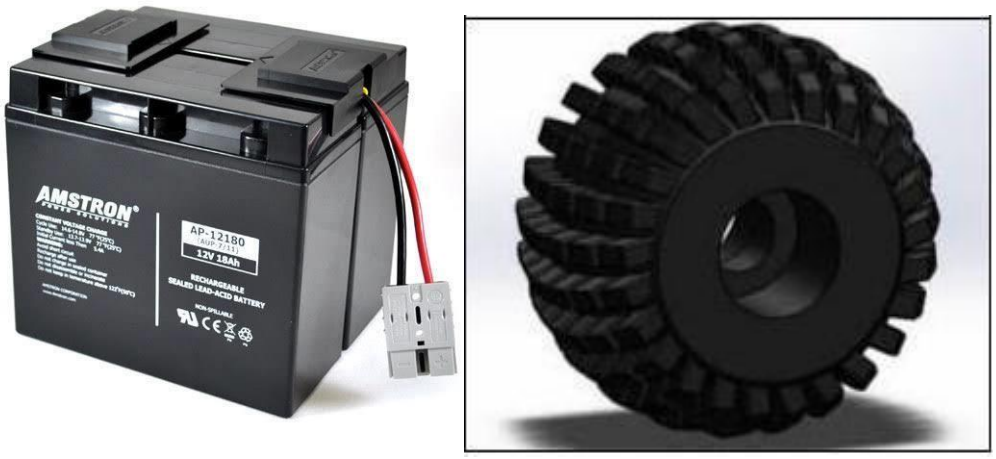


Fig. 4 Shows Battery and Wheel

*C. Solar panel and Arduino*

A solar panel employs solar energy to supply electricity to devices or charge batteries. They are generally portable. Solar chargers can charge lead acid or Ni-Cd battery banks up to 48 V and hundreds of ampere-hours (up to 4000 Ah) capacity. Such type of solar chargers setups are generally used as an intelligent charge controller. A series of solar cells are installed in a stationary location and can be connected to a battery bank to store energy for off-peak usage. They can also be used in addition to mains-supply chargers for energy saving during the daytime.Most portable chargers can obtain energy from the sun only. Some, including the Kinesis K3, and GeNNex Solar Cell 2 can work either way (recharged by the sun or plugged into a wall plug to charge up.

This system can be said as the brain of the vehicle. The controlling system will control all the activities going on the vehicle. The main components of the controlling system are Arduino and Zigbee, boards. The Arduino board is a type of microprocessor which can be used to give commands to the movement of the vehicle. This board is a programmable one and can able to change the instructions according to the user need. The commands needed for the movement and other activities are stored inside the Arduino in form of computer program.The power needed for the working of the Arduino is taken from the external power source and using a regulator to change the current to its need the Arduino will operate the vehicle according to the commands user gives through the laptop. A pair of Zigbee transmitter is also used in the controlling system. These boards are similar to the wi-fi in functioning which helps in transmitting commands from the receiver side to the vehicle

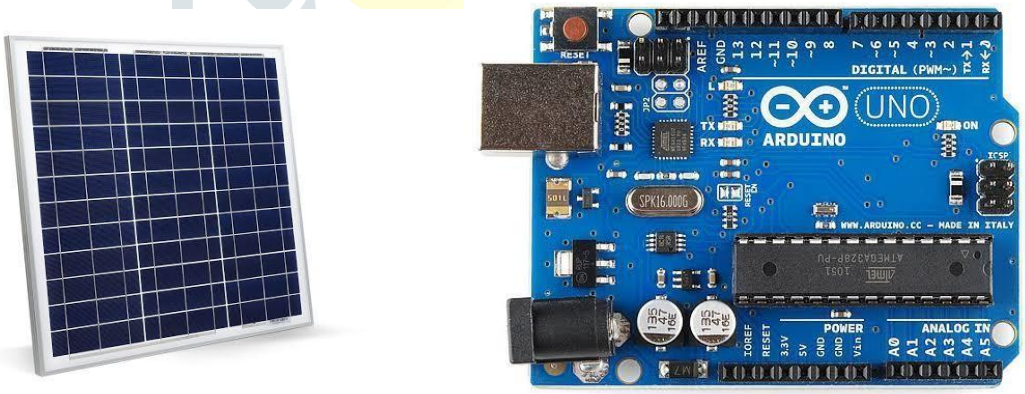


Fig. 5 Shows Solar Panel and Arduino Board

*D. Working*

The rocker-bogie design consisting of no springs and stub axles in each wheel which allows the chassis to climb over any obstacles, such as rocks, ditches, sand, etc. that are up to double the wheel's diameter in size while keeping all wheels on the ground maximum time. As compared to any suspension system, the tilt stability is limited by the height of the centre of gravity and the proposed system has the same.

The main power source of the mechanism is solar energy. Solar panels fitted on the top would consume the solar energy to charge the batteries (batteries are rechargeable) Thepower generate in battery will be used to run the motors which are linked with the wheels. Six wheels with six motors are totally governed by the Arduino sensor connected in the assembly. Remote control device which is totally wire-less will be used to give instructions i.e. Front, Reverse, Turning and Speed. In order to go over an obstacle or steps, the front 2 wheels are forced against the obstacle by the rear wheels. The rotation of the front wheel then lifts the front of the vehicle up and over the obstacle. The middle wheel is the pressed against the obstacle by the rear wheel rotational pressure 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

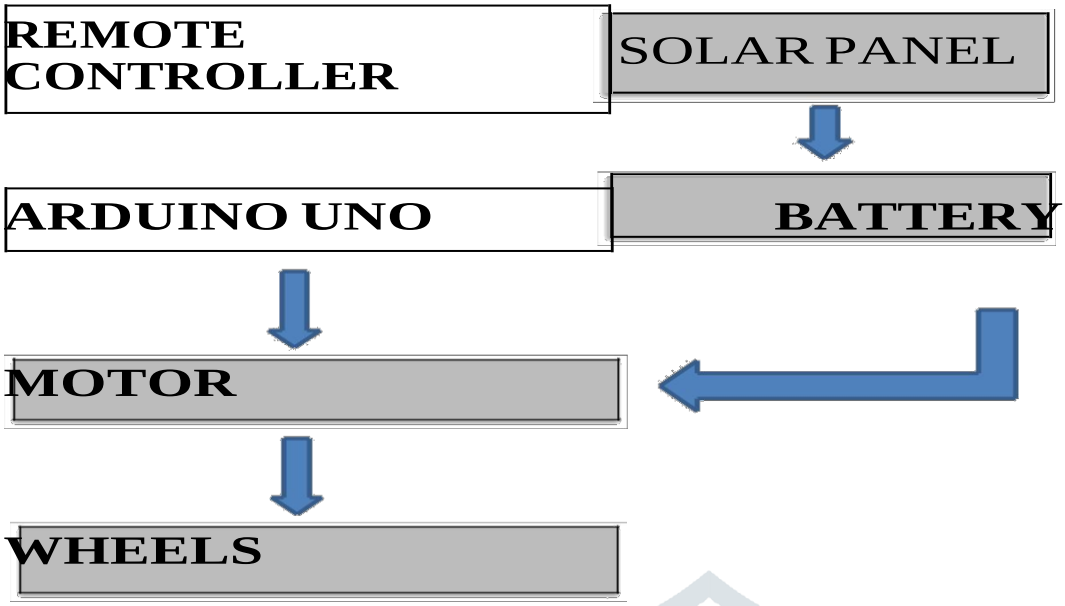


Fig. 6 Shows General Working of Model

## IV. CONCLUSIONS

This is a wide field of study and is very less explored. So this gave us the motivation for the development of this rocker bogie suspension system in a cost effective manner. Our concern during the development of the rover will be to optimize the speed such that the rover do not flip and may travel a little faster too and make it cost effective with maximum possible rigidity and ruggedness. With certain developments the bogie system can be used for defence related operations and also in wheelchairs for climbing stairs.

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