# DESIGN OF A ROCKER-BOGIE SUSPENSION SYSTEM BASED AUTONOMOUS VEHICLE

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*Abstract :* This paper deals with the design and fabrication of a Rocker-Bogie suspension system that is powered by an autonomous driving system. Rocker-Bogie mechanism is well known for its stability in various terrains. This is achieved through three main steps. The first part is design and manufacturing of the Rocker-Bogie mechanism. It includes calculation, CAD modeling and fabrication. The second part is automation. Driving automation is achieved through an ample quantity of sensors and controller. The sensors sense the external environment and the controller gives control commands based on the output from the sensors. The third step is integration. It includes the technique of integrating the fabricated model and the autonomous system designed. The controller commands the actuators and allows the rover to move and decide on its own. The output will be a cost effective, light weight, miniature autonomous rover that is self driving.

***IndexTerms* - Autonomous Vehicle, Rocker-Bogie Mechanism, Self-Driving Vehicle.**

## I. INTRODUCTION

Autonomous vehicle is a concept which has not been only discussed recently. Many studies have been done since late 1920's. As years passes the necessity of having a self-driven vehicle has become more important as there is a drastic increase in the number of accidents and many are losing their life due to the carelessness of people and that's when the idea of autonomous vehicle that has been discussed earlier shows more important to make it practical rather than just having it as a concept and hence several researches are being done and many are still being done[1]. Implementation of the first autonomous vehicle in a basic scale as a trial was done in 1950's. In 1980's was the formation of a self-sufficient autonomous vehicle. Several top vehicle manufacturing companies have done many researches and even tried out many prototypes. Recently autonomous vehicles have been the present trend. In 1939 the automated guided vehicles were introduced by General Motors. In 1953 a miniature car was made which was controlled by wires. As well as in 1990's the world's first driverless car was made which mainly uses artificial reference points which was embedded on the road surfaces to verify and identify the position as well as this did not have a steering wheel and not even a safety driver[5-8].

Because these systems are made in such a way that all the earlier problems are taken into consideration. An autonomous vehicle is a driverless vehicle which is fully automatic. It consist six levels in autonomous vehicles named from level 0 to level 5. Currently Level 2 autonomous vehicles are commercially available [9]. In this level it includes partial automation which is capable of assisting at certain circumstances. Level 0 is not automatic, driver need to take control. Level 1 is automated for certain functions like steering; acceleration etc., Level 2 is partially autonomous such as automatic braking in dangerous situations and cruise control. Level 3 is autonomous but not in heavy traffic. Level 4 is highly automatic in heavy traffic but not in all conditions. Level 5 is fully autonomous in all terrain and environmental conditions. This paper shows the designing of a rocker bogie suspension system which can be implemented so that works as an autonomous vehicle.

Future will be in the hands of automation and autonomous cars rule the roads. Being self driven, autonomous cars will be a cup of pleasure and luxury. It avoids the accidents caused due to human error[14]. Sensor technologies can detect and the actuators take quick actions better than human. It can also be used in the space explorations, underwater explorations, mining, etc. Moreover autonomous vehicles, like the one designed in this project, can be used in the regions where human intervention is more of a danger.

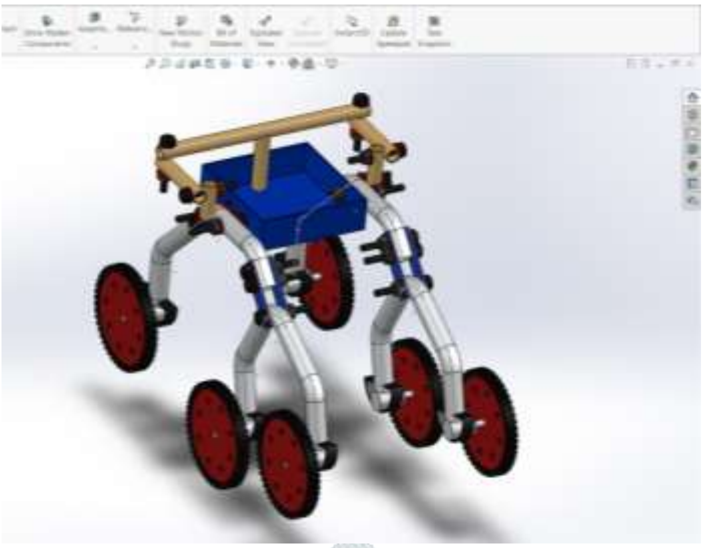


Figure 1 . Design of Rocker bogie System

**Rocker bogie suspension system**

It is such kind of a suspension system used in mars rover and it is a mechanical robot that functions efficiently. On each side of the suspension system it consists of larger links which has a rocking aspect through which the name 'rocker' has been evolved. Differential is the common part that connects both the rockers on each of the sides. The chassis has an ability of maintaining the average pitch angle on both sides of rocker. An end of a rocker is connected to the drive wheel as well as the other end to the bogie. Bogie can be referred as the links that have a drive wheel at each end. Most of the bogies are used on trailers of semi-trailer trucks.

Talking about the design of a rocker bogie suspension system shows its versatility as it has no springs and stub axles for each individual wheels. This design helps the body to climb over different obstacles. It has a capability to climb obstacles that are two times the size of the wheel diameter. Considering any other suspension system the lift stability is limited by the height of center of gravity. A system that uses springs has a tendency to tip more easily as the loaded side yields. There are certain rovers that can withstand an inclination or a tilt of 45 degrees in any direction without a knock over but automatic sensors limit the rover from increasing 30 degree tilt. The framework is intended to be utilized at moderate speed of around 10 centimeters for every second (3.9 in/s) in order to limit dynamic stuns and important harm to the vehicle while surmounting sizable deterrents. The two front and two back wheels have singular controlling engines which enable the vehicle to turn set up. Each wheel likewise has cleats, giving hold to moving in delicate sand and scrambling over rocks.

The most extreme speed of the robots worked along these lines is constrained to eliminate whatever number powerful impacts as could be allowed with the goal that the engines can be equipped down, in this manner empowering each wheel to independently lift an extensive bit of the whole vehicle's mass. So as to go over a vertical obstacle face, the front wheels are constrained against the obstruction by the middle and back wheels. The pivot of the front wheel at that point lifts the front of the vehicle up and over the deterrent. The center wheel is then compressed against the snag by the back haggles against the hindrance by the front until it is lifted up and over. At long last, the back wheel is pulled over the impediment by the front two wheels. Amid each wheel's traversal of the obstacle, forward advancement of the vehicle is impeded or totally stopped. This isn't an issue for the operational rates at which these vehicles have been worked to date.

## II. PROPOSED METHOD

1. Control Loop Formulation

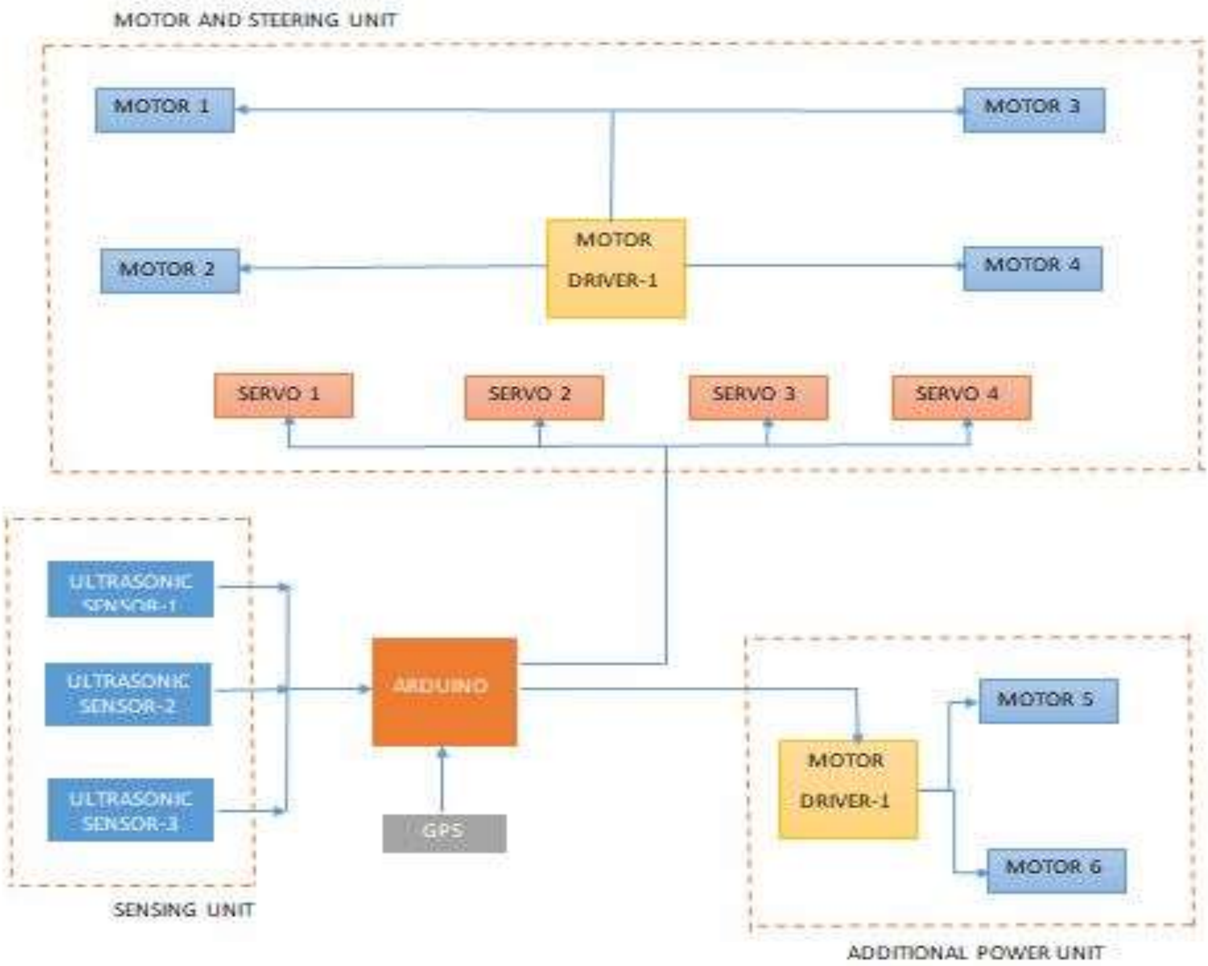
The control system consists of Arduino Micro-controller and two motor drivers which acts the central control units which are connected to different DC motors and sensors. The vehicle is run by four high torque motors which are controlled by one single motor controller. The high rpm motors for additional power is run by a separate motor driver. The data from the sensors considered as input for the arduino micro-controller, these data is used by the controller to determine the path and speed of the vehicle. The coordinates are feed into the controller and with help of GPS module and a magnetometer the vehicle can move from one point to another.

2. Sensing Model :-

The collision avoidance system is built upon four ultrasound sensors which are placed in the front side and back of the vehicle. Using SONAR the HC-SR04 sensors can determine the distance of obstacle ahead of it. These sensors are equipped with a transmitter which sends out the pulse signal and a receiver which will receive the pulse signal after it bounces back by hitting any obstacle in the path. The time taken by the signal to travel fro and back is used to calculate the distance of the object from the vehicle. The sensor are placed in various directions such that it can detect obstacles on various position with respect the vehicle .So based on this data from the sensors the controller categories obstacle position into three categories close, far or collision. These data will be used by controller to decide the speed and direction of the vehicle.

2.1 Motor System

The vehicle system consist of six tyres of which four are powered by low rpm high torque motors and two are powered by high rpm low torque motors .The vehicle will by running on the four low rpm motors most of the time, the additional high rpm motors placed in the center can be used to provide additional power when the vehicle encounters any difficult terrain situations. The two high rpm motors can be powered separately as it is controlled and powered via a separate motor driver. L293 motor driver is used as motor control which regulates motor operations and 100 rpm 12 V dc motors are used on the 4 wheels as high torque motors . The servo motors acts connection joint between the body and wheels which enables 180 degree rotations for the four wheels.




2.2 GPS Navigation

The vehicle can be made to movie from point A to point B by feeding in the longitude and latitude coordinates of the points or locations. This made possible by using a neo 6M GPS module and a magnetometer . The GPS module tracks the current position of the car while magnetometer gives the current heading . When the car encounter with any obstacle it changes the path to avoid collision , it again then reroutes back to original path by comparing and making a matching between target heading and current heading The following logic is applied.

## III. CONCLUSION

The autonomous rover is of 30cm length 25cm height and 20cm breadth. During the testing phase it is understood that the 9volt batteries are not delivering enough power to the motors hence we upgraded the L239D motor driver and connected two 9 volt batteries in series so that it delivers more power. Through this paper the model and the methods and basic ideas about an autonomous vehicle are depicted in smaller scale which may be helpful for many more future works.

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