

## **Licensing and Technology Transfer Opportunity: Manipal University**

### **Title of Technology Available:**

### **Pantograph Suspension System and Method For Vehicles**

#### **Brief Description of Invention:**

The present invention is particularly related to a system and method of a pantograph suspension systems used in off-road vehicles such as mobile robotics, planetary exploration rovers, and unmanned vehicles. The present invention is more particularly related to a system and method for automatically adjusting pantograph suspension system which is designed to self-adjust a clearance, suspension length and angle of suspension up to pre-set limits depending upon the terrain of travel without using any actuators to provide an increased climbing capacity and better traction to reduce the loss of wheel power due to slipping.

#### **Brief Background of Invention:**

Advances in technology has enabled engineers to expand in the field of automobile and robotics. The advances and changes happened to the suspension systems of a vehicle is remarkable. A suspension system is an arrangement of tires, springs, shock absorbers and linkages that connects a vehicle to wheels. The suspension system allows a relative motion between the vehicle and the wheels. The suspension system is designed to control the handling and braking capacity of the vehicle for safety purposes, thereby providing comfort to the passengers from bumps and vibrations, to maintain a correct vehicle height and wheel alignment.

Different mechanism of suspension system have been used in off-road vehicles. One of the popular designs or techniques is a rocker-bogie suspension system. The rocker-bogie suspension system is a very flexible suspension system and is appropriate for rough terrain. The rocker-bogie suspension system is a swivel type suspension attached to the rocker arm which in turn is pivoted to chassis of the off-road vehicle. The suspension angle of the rocker-bogie suspension system remains a constant. Typically, the vehicles utilizing rocker-bogie suspension system are designed to traverse obstacle having heights of less than about one and half times the wheel diameter. Though, the rocker-bogie suspension system are designed to encounter and traverse the large obstacles they have no constraints on the linkage motion which may cause instability in the suspension system. Further, the design of rocker-bogie suspension system has other limitations such as slow speed and wheelie problem.

Hence, there is a need for a system and method for designing, developing and modelling a pantograph suspension system for off-road vehicles. There is also a need for a system and method for automatically adjusting suspension system for pantograph suspension system to self-adjust clearance, suspension length and angle of suspension up to pre-set limits. There is further a need for developing a pantograph suspension system with increased climbing capacity and better traction.

#### **Describe the final product:**

The present invention, a pantograph suspension system with an increased climbing capacity of an off-road vehicle comprises a plurality of mechanical links, a plurality of pivot joints and a spring damper. The plurality of mechanical links are configured for climbing obstacles encountered by the off-road vehicle. The plurality of mechanical links includes a first link, a second link, a third link and a fourth link and the plurality of links are interconnected with each other. The plurality of links includes a plurality of binary links and a plurality of ternary links. The plurality of pivot joints are configured for interconnecting the plurality of mechanical links and suspending the pantograph suspension system on a body of the off-road vehicle. The spring damper is connected between the first link and the third link. The spring damper is configured to automatically adjust a suspension angle of the pantograph suspension system to be within a predefined limit. The suspension angle is automatically adjusted due to expansion and compression of spring damper based on the obstacle encountered by the off-road vehicle. The suspension angle is varied or adjusted to vary or adjust the distance between the third link and the fourth link to increase the climbing capacity of the off-road vehicle.

**Technological Domain (Keywords):**

Suspension system, trackless Tank suspension, off-road vehicle suspension, Exploration rover suspension, rocker bogie, off road autonomous vehicle, disaster rescue and relief bot, Suspension system for Excavators, off road military vehicles. Truck suspension system.

**Proof of Concept:**

The concept is analytically proved. The simulation of pantograph suspension system on ADAMS and Matlab Simulink showed promising results. The suspension system is stable for a vertical step of 330mm, Centre of mass of pantograph suspension shifted by 25 mm while for rocker bogie the Centre of mass shifted by 60mm in vertical direction. Similar results are received for sinusoidal surface having amplitude of 100 mm, bogie suspension mounting point lifts by 50mm while pantograph suspension system mounting point lifts by only 20 mm. This induces stability in system due presence of dampers. This system reduces wheele issue of rocker bogie suspension. Current work is going on prototyping of the model and testing parameters of stability

**Stage of Development:**

Ideation/**Prototype**/Advanced Prototype/Ready to Market technology: **Prototype**

Provide Information on Competitors who manufacture and/or sell similar products: NA

**What are the unique advantages your innovation has compared to the competition?**

A few potential companies who might be interested in this technology: ISRO, DRDO, truck or excavator companies.

Intellectual Property Status: Indian Patent application with number 201741047120 filed in (December 28, 2017)