



Electrically Powered Active Suspension Systems

A novel, electrically powered, active variable geometry system developed by engineers at Imperial. Electrically Powered Active Suspension Systems provide the smooth and stabilising performance of an active control system with a compact, low cost, low power, fail-safe system.

Background and problem addressed

Active and Semi-Active suspension systems are deployed in passenger vehicles to provide a smooth and controlled ride for passengers by counteracting the effects of uneven road surfaces, roll whilst cornering and dive during braking. Existing systems use either hydraulic (and other fluids-based systems) or direct electromagnetic mechanical intervention on the spring/damper system. Both approaches create disadvantages in terms of system complexity, weight, power requirements and cost.

Technology overview

A novel, electrically powered, active variable geometry system developed, provides the smooth and stabilising performance of an active control system with a compact, low cost, low power, fail-safe system using a high speed geared, rotatory actuator. Developed by engineers at Imperial College London, the system is available in two basic configurations:

Series Active Variable Geometry Suspension (SAVGS)- Suitable for medium and light passenger vehicles. The SAVGS system improves ride comfort and road-holding, offers low power consumption, has low mass and is inherently fail safe. The main feature of this system is the addition of a short link arm between the upper end of the conventional spring damper unit which is driven by a rotatory actuator

Parallel Active Link Suspension (PALS)- Suitable for heavier vehicles e.g. sports utility vehicles (SUV). This system introduces a rocker-pushrod assembly between the chassis and lower wishbone in either a double wishbone or MacPherson strut arrangement. This rocker-pushrod is driven by a rotatory actuator which actively changes the wheel travel position and loading, enabling adjustment of the chassis attitude, and reduced heave, roll and pitch acceleration.

The main difference between these systems is that, in SAVGS the link arm and actuator act in series with the spring damper unit and in-effect have to carry the sprung mass, the PALS arrangement avoids the need to support the sprung mass, as the rocker-pushrod and the actuator act in parallel with the spring damper unit. In both cases, the actuator system has the desirable feature that it adds effectively negligible mass to the unsprung mass and a relatively small mass when compared with existing systems.

Benefits

- Low cost, light weight, low power active control suspension system compared with conventional systems.
- Fail safe.
- Electric actuation simplifies control and power systems.
- Addition of negligible mass to the unsprung mass.

Applications

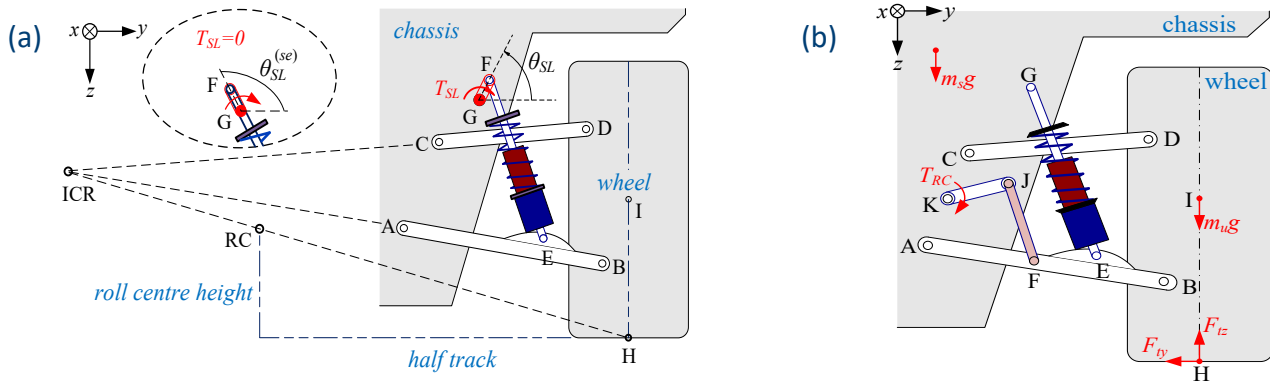
- Two configurations:
 - SAVGS for light weight vehicles.
 - PALS for SUV and heavy duty requirements.

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Technology reference: **4818 (SAVGS)**
and **7762 (PALS)**



(a) The *Series Active Variable Geometry Suspension* applied to a double-wishbone suspension. ‘RC’ is the vehicle roll centre and ‘ICR’ is the instantaneous centre of rotation. θ_{SL} is the single-link angle with respect to the horizontal plane. The superscript (*se*) denotes the static equilibrium state with zero torque ($T_{SL}=0$) applied on the single-link; (b) The *Parallel Active Link Suspension* application to a double-wishbone suspension. T_{RC} is the rocker torque, m_s is the quarter car sprung mass while, m_u is the unsprung mass, F_{tz} and F_{ty} are the vertical and the lateral tire force, respectively.

Intellectual property information

These technologies are patented:

Variable geometry suspension apparatus and vehicle comprising such apparatus (SAVGS): Granted patent in the US (US9026309), Canada (CA 2809542), China (CN103282219) and published in Europe as (EP2608972).

Vehicle suspension system (PALS): Accepted for Grant in Europe (EP 3600924) and pending in US (application number 16/4945533), China (CN110494307) and Japan (JP2020-511366)

Inventor information

The lead inventors are [Professor Daniele Dini](#), Head of the Tribology Group at Imperial College London covering a wide range of multidisciplinary projects modelling tribological systems and materials and [Dr Simos Evangelou](#), Reader in Systems Engineering in the Department of Electrical and Electronic Engineering with an interest in solving problems associated with complex dynamical systems by applying control engineering.