Off-road vehicle dynamics: Stability, ride comfort, vehicle performance and modeling

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Off-road vehicle engineering studies the overall performance of a vehicle in relation to its operating environment—the terrain. Terrain–vehicle mechanics is concerned with the tractive performance of a vehicle over unprepared terrain, ride quality over unprepared surfaces, handling, obstacle negotiation, water crossing, and other related topics. This field aims to provide guiding principles for development, design, and evaluation of off-road vehicles. Wheeled off-road vehicles are the wheeled vehicles subjected to complex external forces induced by traversing over irregular and harsh terrain and surfaces. As an important component of the wheeled vehicles, tires have significant effect on the response of the vehicle and the driver to the road excitation and hence are pivotal in the vehicle dynamics analysis. The study of tire dynamics is an involved and complex field mainly because of the tires' composite structure and nonlinear material properties. The role of wheels in vehicle dynamics is considerable given that wheels are the unique elements that connect the vehicle body to the ground, and they are subject to all of the forces and torques applied to the vehicle. The steering, braking, acceleration, traction, handling, and stability are all realized or affected by the wheels.

Vehicle motions are largely due to the shear forces between the tires and the road, and therefore, the tire model is an essential part of the mathematical modeling of the wheeled vehicles. The tire model must produce realistic shear forces during braking, acceleration, cornering, or any combination of these on a preferably wide range of surface conditions. Then, the developed model could serve as a functional catalyst to further study the vehicle motion from kinetics and kinematics in terms of improving steering, suspension, and traction control systems, wherein optimizing vehicle performance has led to the development of new and more efficient systems.

The modeling of the vehicle behavior, characterization of the mechanical properties of the vehicle components pertinent to vehicle mobility, and the mechanics of vehicle–terrain interaction are consequential in vehicle dynamics. As the performance of the off-road vehicles over unprepared terrain constitutes a central issue in vehicle mobility, this Special Issue focuses on the study of off-road vehicle dynamics, in particular, on the kinetics and kinematics of the off-road vehicles from the stability, ride comfort, vehicle performance, and modeling perspectives.

Vehicle performance refers to the vehicle behavior in terms of its transient performance, for example, acceleration, braking, and cornering, and its steady-state performance, for example, power driveline losses, gross and net traction, and vehicle aerodynamics. Some attributes or aspects of vehicle dynamics are purely aerodynamic or based on geometric mass and its distribution and tires. We invited researchers to contribute their original research articles as well as review articles focused on kinematics and kinetics of off-road vehicle from stability, ride comfort, vehicle performance, and modeling perspectives. Particular attention is given to enhancements of emerging technologies dealing with the modeling of vehicle dynamics and optimization of the associated systems of the off-road vehicles traversing over irregular terrains.

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