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A Holistic Multi-Objective Framework for the Optimal Design of Vehicle Subsystems

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Optimal design of vehicle subsystems has progressively evolved toward multidisciplinary and multi-objective approaches, in which mechanical architecture, control design, structural efficiency, and energy performance are addressed within a unified framework. This perspective is consistently adopted in the development of advanced road-vehicle subsystems, with particular emphasis on suspensions, vehicle control systems and electric powertrains.

In suspension design, RL multi-objective elasto-kinematic optimization methods can be applied to identify solutions capable of balancing competing requirements, such as ride comfort, handling and robustness against parameters uncertainties. Another important research direction concerns urban electric mobility and quadricycles, where the vehicle should be conceived as an integrated system in which lightweight construction, suspension configuration, energy consumption, and powertrain sizing must be optimized concurrently. Studies on ultra-efficient electric vehicles and urban quadricycles show that reducing energy demand while ensuring functional performance can only be achieved through the concurrent co-design of structural components, driving strategy, and propulsion systems.

Integrated optimization strategies make it possible to capture the strong interdependence among mechanical design, control, and energy efficiency. This approach therefore provides a rigorous foundation for the development of vehicles that are safer, lighter, and more sustainable.

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