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SIMULATION-BASED OPTIMIZATION OF A TRACKED VEHICLE SUSPENSION SYSTEM

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Abstract

This research considers simulation-based optimization of a tracked vehicle suspension system. We focus on maximizing ride quality across a large spectrum of operational conditions rather than specific terrain/speed combinations, using surface roughness to guide our exploration of diverse scenarios.

The vehicle suspension system features 14 torsion rods and dampers subject to optimization. Using multibody dynamics simulation, we evaluate ride quality over diverse terrains at varying speeds, computing whole-body acceleration and vibrational dose values (VDV).

We analyze and compare alternative ways of posing and solving the problem of finding a suspension configuration that is optimal for a desired spectrum of terrains. We consider derivative-free optimization methods, including Particle Swarm Optimization (PSO) and Bayesian Optimization, and compare these to first learning and pre-building a surrogate model, prior to optimization. This surrogate strategy relates local terrain characteristics to vehicle performance metrics, such as acceleration-constrained velocity limits.

Preliminary work with PSO demonstrated significant ride quality improvements, with VDV reductions of 20-60% compared to baseline configurations, but was limited to optimizing only torsion rods for specific terrain/speed combinations. Our current research extends this by simultaneously optimizing both suspension and damping parameters and implementing an aggregated approach that optimizes performance across multiple terrains and velocities in a single cycle.

This work demonstrates how simulation-based optimization techniques can significantly reduce whole-body vibrations in tracked vehicles, improving both operational capabilities and crew endurance in challenging environments.

Keywords: Simulation-based optimization; Multibody dynamics; Tracked vehicle suspension; Ride quality optimization; Derivative-free optimization; Surrogate modeling.

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