

Abstract

Resolving the trade-offs between suspension travel, ride comfort, road holding, vehicle handling and power consumptions is the primary challenge in designing Active-Vehicle-Suspension-Systems (AVSS). Controller tuning with global optimization techniques is proposed to realise the best compromise between these conflicting criteria. Optimization methods adapted include Controlled-Random-Search (CRS), Differential-Evolution (DE), Genetic-Algorithm (GA), Particle-Swarm-Optimization (PSO) and Pattern-Search (PS). Quarter-car and full-car nonlinear AVSS models that incorporate electrohydraulic actuator dynamics are designed. Two control schemes are proposed for this investigation. The first is the conventional Proportional-Integral-Derivative (PID) control, which is applied in a multi-loop architecture to stabilise the actuator and manipulate the primary control variables. Global optimization-based tuning achieved enhanced responses in each aspect of PID-based AVSS performance and a better resolve in conflicting criteria, with DE performing the best. The full-car PID-based AVSS was analysed for DE as well as modified variants of the PSO and CRS. These modified methods surpassed its predecessors with a better performance index and this was anticipated as they were augmented to permit for efficient exploration of the search space with enhanced flexibility in the algorithms. However, DE still maintained the best outcome in this aspect. The second method is indirect adaptive dynamic-neural-network-based-feedback-linearization (DNNFBL), where neural networks were trained with optimization algorithms and later feedback linearization control was applied to it. PSO generated the most desirable results, followed by DE. The remaining approaches exhibited significantly weaker results for this control method. Such outcomes were accredited to the nature of the DE and PSO algorithms and their superior search characteristics as well as the nature of the problem, which now had more variables. The adaptive nature and ability to cancel system nonlinearities saw the full-car PSO-based DNNFBL controller outperform its PID counterpart. It achieved a better resolve between performance criteria, minimal chatter, superior parameter sensitivity, and improved suspension travel, roll acceleration and control force response.