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ROBUST DESIGN OF A SEMI-ACTIVE SUSPENSION SYSTEM BY MEANS OF SIMPLIFIED PHYSICAL MODELS AND CONSTRAINED MULTI-OBJECTIVE EVOLUTIONARY OPTIMIZATION

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ABSTRACT

In the automotive industry, designers have often to cope with complex multidisciplinary vehicle systems, whose performance and robustness have to be considered at early stages of the design process. The main challenge is to ensure that effective and competitive solutions are found in minimum time. A semi-active suspension is an example of such a system which has to meet several conflictive performance requirements under uncertainties and constraints.

A robust design methodology, called FIRST DESIGN [1], is used to make the descent of the V-diagram more reliable. In order to allow innovative actuators and organs to be imagined, this methodology makes a strong distinction between the functional and the organic architectures of the design. It also relies on hierarchical optimization of the design variables for better computational performance and robustness. Instead of a complete vehicle model, which is able to simulate real driving situations but too complex and time-consuming for efficient optimization, several simplified models are used. Each of them is dedicated to a previously identified elementary driving manoeuvre, whose performance was objectified. In fact, the complexity of the models is progressive and always consistent with the information available at the current phase of the project. On these decoupled models, a constrained robust optimization based on a multi-objective evolutionary algorithm (MOEA) is performed. At each step, an entire set of non-dominated compromise solutions is obtained. Therefore, the designer is able to select wanted solutions in accordance with envisaged typing, product line or robustness level.

This paper presents some of the used models and returned results, for the functional specification of robust sets of semi-active suspension's design variables. It particularly focuses on direct integration of robustness into the optimization procedure [2] and on the treatment of a highly multi-objective problem [3,4]. The requirements considered for the suspension system are steady-state and transient cornering, braking, vertical ride comfort and preliminary placement of the chassis eigenmodes.

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