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Development of System Characteristic Optimization Method to Achieve Vehicle Target Performance

Jin Hee Lee[1]

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Abstract
The application of 'Target Cascading' in the product development process is well known to be effective in various industry fields, and it is a methodology that is already actively applied in various forms in the field of vehicle Ride & Handling (R&H) performance development. This paper proposes a model-based vehicle performance benchmarking methodology and a technology for setting system characteristics to achieve handling performance objectives as a means of utilization for this. Rather than introducing already well-known target deployment techniques, a process is proposed for practical use in the vehicle development phase through the development of interfaces between low degrees of freedom vehicle model and optimization software. The methodology presented in this study is expected to be available in a timely manner as a practical vehicle performance development tool.

Keywords Vehicle dynamics · Handling performance · CAT · Optimization · Target cascading

1 Introduction

The method of 'Target Cascading' in the product development process is known to be an effective method regardless of its detailed field. This method is to propagate the desirable top-level target to the sub-level system to determine its characteristics or specifications. System characteristics that achieve target of the upper level are propagated as a new target for the lower level sub-system or components and demand specifications of the components that satisfy them. Through this concept, design problem that is complex and involves a lot of things can be simplified. Also, it is possible to maintain consistency of the development process and avoid or minimize the repetition of similar process. This means that the overall efficiency of product development increases (Kim et al., 2003). Effect of this target cascading process is actually maximized when applied with the CAE model. If the model reflects the overall elements of the product and it is highly consistent, the methodology will work more powerfully. In addition to this, development and improvement of the multidisciplinary design optimization methods (Cramer et al., 1994; Kodiyalam et al., 2000) associated with CAE technique accelerates the completeness of the target cascading methodology. This is because the number of targets and design variables can vary depending on how the problem is defined.

In the automotive industry, this methodology has been applied in a variety of ways. One of them is to derive design specifications to achieve system and sub-system level requirements. Kang et al. (2014) designed suspension system to find optimal leaf spring stiffness, gap of the spring, and camber angle for the front (1st and 2nd) and rear suspension to satisfy axle load target. As a lower level of this problem, dimensions of the leaf springs were also optimized to achieve target stiffness of the leaf spring. Shintani et al. (2019) applied this target cascading method to design problem of torsion-beam type suspension. They optimized characteristics related to torsion-beam axle (moment of inertia, torsional stiffness, etc.) and bush stiffness for each direction as a sub-system level to satisfy some system level requirement, such as eigen frequency and so on. Dimensions of the torsion beam and the hardness of the rubber bush were used as lower level design variables. This method has been already actively applied in various forms in the field of vehicle R&H performance development, too. Kang et al. (2011) have been proposed robust process to optimized vehicle ride

✉ Jin Hee Lee
jinhee.lee@hyundai.com

[1] Driving Performance Technology Team, AVP, Hyundai Motor Company, 150, Hyundaiyeonguso-ro, Namyang-eup, Hwaseong-si, Gyeonggi-do 18280, South Korea