Error Assessment of Response Time Histories (EARTH): A metric to validate simulation models

Harshit Sarin

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Abstract

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by Harshit Sarin

Chair: Panos Papalambros

Co-chair: Michael Kokkolaras and Greg Hulbert

Computer modeling and simulation are the cornerstones of product design and development in the automotive industry. Computer-aided engineering tools have matured to the extent that virtual testing and electronic certification of vehicle designs are a tangible possibility. In order to make this a reality, we need to assess our confidence in the predictive capabilities of simulation models. As a first step in this direction, this thesis deals with developing a metric to validate simulation models with a focus on vehicle safety applications.

Emphasis is given on quantifying discrepancy between time histories as the latter constitute the predominant form of responses of interest in vehicle safety considerations. We first evaluate popular measures used to quantify discrepancy between time histories in fields such as statistics, mathematics, computational mechanics, signal processing, and data mining. A structured unification of some of these measures that forms a comprehensive metric that encapsulates the important aspects of time history comparison is then proposed. The new metric (called EARTH for error assessment of response time histories) classifies error components associated with three physically meaningful characteristics (phase, magnitude, and topology), and utilizes existing measures (cross-correlation and L_1 norm) and algorithms (dynamic time warping) to quantify discrepancies. Two case studies demonstrate that the

proposed metric seems to be more consistent than existing metrics. Moreover, it is shown how the metric can be used in conjunction with subject matter experts data to generate validation models.