Abstract:

Full-vehicle finite element models have a large number of degrees of freedom. This makes them ill suited for design work, numerical optimization or stochastic analyses in an early development phase, because they require a high level of detailed information, most of which is yet unavailable. They are also computationally expensive, thus severely limiting the number of function evaluations. Both difficulties can be alleviated through the use of substitute models, which capture only the relevant mechanisms, associated with a smaller number of degrees of freedom. This work provides a substitute modeling and calibration methodology which improves output value prediction for substantial deviations from the reference design, including three significant innovations. First, a new measure to quantify the agreement of calibrated and reference model is proposed. Second, a multi-model calibration is introduced, which incorporates an array of reference models for calibration and cross validation. Third, the calibration is performed on the basis of a hybrid objective function, weighting the agreement of the time dependent system states, called physics-based contribution, and the time independent output values, called predictive or
regression-based. This ensures a large range of validity while simultaneously improving the predictive quality of the model. It is also shown that the discretization of the structural mass has negligible influence on the target values, allowing for reduced model complexity.

Stichworte: Optimization; Surrogate model; Crashworthiness; Parameter identification; Model calibration – Lumped mass models

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