Comparison of Input Interval Field Definitions on Structural Finite Element Models

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Abstract

In uncertainty quantification, interval arithmetic provides an appropriate procedure when little knowledge is available on the nature of the probability distribution of uncertain or imprecise quantities. This commonly occurs in engineering applications due to subjective knowledge or incomplete availability of test data. Intervals are by definition unable to take into account dependent input and output quantities, which forces the assumption of independency when applying them. This is a severe limitation on the accuracy of the analysis as dependency is always present to some extent. According to Moens et al. (2011), the concept of interval fields (IF) provides a solution by defining non-deterministic fields using interval parameters. In its simplest form , the field is expressed as a weighted sum of basis functions, the weights being modelled using interval parameters. The dependency within the field is then captured by the basis functions, which describe the spatial nature of dependency, whereas the magnitude of uncertainty is captured by the weights. Field parameters are usually associated to geometric quantities (such as plate thickness), but they can be applied generally whenever multiple uncertain input or output quantities are involved. Both at the input and output side of a numerical analysis, IF can be used for a more realistic description of the estimated uncertainty. This paper specifically concerns the application of IF at the input side of uncertain Finite Element analysis. Within the framework of explicit interval fields as defined by Verhaeghe et al. (2013), multiple ways of defining the dependency have led to different IF definitions. In this paper, two different definitions will be applied to a FE-model of limited complexity and propagated to obtain the uncertainty on dynamic output parameters, with the purpose of comparing the resulting output uncertainty and propagation time.

References

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