Bounding the dependency measures for spatial uncertainties

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Abstract

The analysis and design of mechanical engineering systems requires to take into account the influence of uncertainties on the system's performance. Depending on the available amount of information, the designer or analyst can choose from a wide variety of methods in the probabilistic (see e.g. Schuëller (2001)) or non-probabilistic (see e.g. Elishakoff and Ohsaki (2010), Moens and Hanss (2011)) approaches to describe the uncertainties. However, the selection of a suitable uncertainty model for the different uncertainties most often is not enough to yield satisfactory information on the reliability or bounds of the system's performance. A crucial piece of information appears to be the dependency of the uncertainties. This is especially the case for uncertainties with a spatial character, e.g. material properties or distributed loads.

The study gives an overview of the existing probabilistic and non-probabilistic methods to represent this kind of dependencies. In the probabilistic setting the concepts of the covariance function associated with a random field, a copula and joint distribution function are treated. In the non-probabilistic setting the concepts of interval fields, convex modeling and interactive fuzzy numbers are reviewed. Of special interest is the ability to bound these dependency measures. For the case of a spatial uncertainty, this generally comes down to specifying the maximum distance between points that are influencing each other. Points further away from each other than this distance are considered independent. For points closer to each other than this distance the interaction needs to be described, introducing a notion of perfect dependency. Finally, of utmost importance is to study the effect of the bounds on the dependency on the uncertainty in the system's performance.

References

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