Chair for Reliability Engineering

dortmund university

Addressing Interval Uncertainty on Boundaries without Remeshing

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Context

The finite element method is an extremely convenient means for analysing different types of problems in mechanical engineering. Its practical application involves defining, for example, boundary conditions, material properties, loadings, etc. In practical applications, there may exist uncertainty regarding the boundary of a problem. This is of much relevance, as it becomes necessary to identify the effect of this uncertainty onto the responses of interest of a model, such as displacements and stresses. Nonetheless, quantifying such uncertainties may be quite challenging, as it demands remeshing the finite element model. Therefore, there is the need for developing numerical tools that are capable of quantifying uncertainty regarding boundary conditions in an efficient way.

Objectives

The purpose of this project is to develop a numerical strategy to quantify the uncertainty associated with the response of numerical models that possess uncertain boundary conditions. It is assumed that uncertainty is described in terms of intervals, which are a widespread model that is particularly well suited for situations where information is scarce. Specific goals to achieve the aforementioned objective are the following.

- Understand and implement basic methods for uncertainty propagation considering intervals [1].
- Examine existing alternatives for avoiding remeshing [2].
- Apply the previous developments to a case study pertinent to mechanical engineering.

Required Skills

To develop this project, the following skills are considered a plus.

- Strong mathematical background.
- Knowledge of software for numerical analysis (e.g. Matlab) and simulation (e.g. Abaqus).
- Reading and writing skills in English.

Application

In case that you are interested in this project, please follow these steps.

1. Read the associated bibliography (see below).
2. Prepare a short motivation letter addressing the following issues:
    a. Your interest in developing this project.
    b. The reasons that make you a good candidate for developing this project.
    c. Intended dates for working in the project.
3. Send the motivation letter to the supervisors via E-mail and ask for an exploratory meeting.

Bibliography

1. M. Faes and D. Moens, “Recent Trends in the Modeling and Quantification of Non-probabilistic Uncertainty,” Archives of Computational Methods in Engineering, vol. 27, Art. no. 3, Jul. 2020.
2. Z. Zheng, M. A. Valdebenito, M. Beer, and U. Nackenhorst, “A stochastic finite element scheme for solving partial differential equations defined on random domains,” Computer Methods in Applied Mechanics and Engineering, vol. 450, February 2023.