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Masterarbeit - *Master thesis*

für

Vorname Nachname

Matrikel-Nr.: XXXXXXXX

Ausgabe der Arbeit: XX.XX.20XX	Bearbeitungsumfang: 150 h (5 LP)
Abgabe der Arbeit: XX.XX.20XX	Bearbeitungsdauer: 6 Monate
Prüfer/in: Prof. Dr.-Ing. U. Nackenhorst	Betreuer/in: Ammar A. Basmaji

Stochastische isogeometrische Analyse unter Verwendung der B-Spline-Chaos-Erweiterung im Zusammenhang mit der Methode der nichtlinearen finiten Elemente

Stochastic isogeometric analysis using B-spline chaos expansion in the context of non-linear finite element method.

Isogeometric analysis which extends the finite element method through the usage of B-splines has become well established in engineering analysis [1]. This concept has be extended for uncertainty quantification analysis where the stochastic output can be represented by a series of B-spline basis functions [2]. Unlike the traditional polynomial chaos expansion where high order orthogonal polynomials exhibit oscillation and inaccurate approximation of the output probability density function and the statistical moments, the B-spline chaos is more accurate in approximating the variances and probability distributions of oscillatory, nonsmooth, and nearly discontinuous functions, an example of B-spline in linear elastic problem can be found in [3]. However, for high dimensional random inputs the multi-dimensional B-spline basis functions are constructed using a tensor product of 1D B-spline which imposes a heavy computational burden. In addition to the limitation to deal with Gaussian input random variables compared with Hermite chaos.

The main goal of this thesis is to investigate the efficiency and accuracy of B-spline chaos expansion compared with traditional orthogonal polynomials, particularly with high dimensional non-linear problems where the uncertain parameter is represented by random fields discretised by Karhunen Loeve expansion.

Required knowledge: Stochastic Finite Element Method, Isogeometric analysis, Finite Element Method, Uncertainty Quantification, Matlab programing.

The entire workload contains the following steps:

1. Preparing a milestone plan for a regular discussion of progress with the supervisor. The milestone plan needs to be handed in one week after receiving the task description. In case of circumstances, the milestone plan needs to be updated as agreed upon the supervisor
2. Literature review on isogeometric analysis and B-spline chaos expansion.
3. Summary of the theoretical background of the B-spline chaos expansion with high-dimensional and non-smooth responses.
4. Implementation of B-spline expansion for non-linear structural problems (i.e. elasto-plastic or damage model).
5. Documentation of all steps and results regarding established scientific standards.
6. Self-evaluation of the own work using the attached evaluation matrix.
7. Creating a poster for the invitation to the presentation.
8. Presenting (15 to 20 minutes) of the thesis within a colloquium.

In addition to an abstract in English and in German, five content describing key words have to be stated. The written report is to be submitted in one printed version. Additionally, all data are to be attached digitally.

Literatur:

[1] J. AUSTIN COTTRELL, THOMAS J. R. HUGHES, YURI BAZILEVS, : Isogeometric Analysis: Toward Integration of CAD and FEA.

[2] G. SHARIF RAHMAN (2019): A Spline Chaos Expansion. SIAM/ASA J. UNCERTAINTY QUANTIFICATION.

[3] CHRISTOPH ECKERT, MICHAEL BEER AND POL. SPANOS (2020): A polynomial chaos method for arbitrary random inputs using B-splines. Probabilistic Engineering Mechanics 60.