



HAL
open science

Multiscale uncertainty quantification in friction interfaces for structural nonlinear dynamics

Enora Denimal, Jie Yuan

► **To cite this version:**

Enora Denimal, Jie Yuan. Multiscale uncertainty quantification in friction interfaces for structural nonlinear dynamics. UNCECOMP 2023 - 5th International Conference on Uncertainty Quantification in Computational Science and Engineering, Jun 2023, Athens, Greece. pp.1. hal-04166776

HAL Id: hal-04166776

<https://inria.hal.science/hal-04166776>

Submitted on 20 Jul 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Multiscale uncertainty quantification in friction interfaces for structural nonlinear dynamics

Enora Denimal*, Jie Yuan**

*University Gustave Eiffel, Inria, COSYS/SII, I4S, Campus de Beaulieu, Rennes, 35042, France #

**Aerospace Centre of Excellence, University of Strathclyde, Glasgow, G1 1XQ, UK#

Abstract.

Many nonlinearities and uncertainties emerge from friction interfaces present in large structural assemblies. They impact significantly the dynamic response and require specific attention. Usually, a macroscopic modelling of the contact surface is employed, coupled with a contact friction law. The latter depends only on a few parameters experiencing large variability leading to uncertain predictions of the dynamic response. Many works have been dedicated to the uncertainty propagation and quantification in friction interfaces using macro-scale modelling. But, it appeared from recent works that the macroscale modelling is not able to capture the physics taking place at the friction interface and that the micro-scale contact model must be considered. Therefore, it is required to develop an efficient multi-scale modelling approach to propagate friction contact uncertainties from the mesoscale to the macro-scale to improve the prediction of the full nonlinear dynamic response. In this context, this work aims to investigate the interest in multi-scale uncertainty quantification for nonlinear dynamic systems with friction interfaces. The focus of this work is to quantify and link the uncertainties from friction interfaces at different scales to the nonlinear dynamic response of the structure.

The test case is based on a fan blade root test rig setup, illustrated in Fig. 1(a). The friction interfaces are at the function between the blades and the discs. The nonlinear dynamic response is characterised by the computation of the nonlinear normal modes (NNM) of the mechanical structure. First, the pressure and gap distributions at the contact interfaces are obtained accurately introducing mesoscale considerations. Then, using these real pressure and gap distributions, the NNMs are computed. Uncertainties on mesoscale parameters controlling the surface shape are considered. This uncertainty is propagated through the different scales to obtain the random contact gap and pressure distribution as well as NNMs. Multiscale PCE is exploited in this work for this propagation and is compared to kriging. Results show that such an approach allows getting deep insights into the system understanding for a reduced numerical cost compared to Monte Carlo simulations.

Acknowledgement The authors acknowledge the support of RSE Saltire Facilitation Workshop Award (No.1865).

References

- [1] Yuan, J., Salles, L., Schwingshackl, C. (2022). Effects of the geometry of friction interfaces on the nonlinear dynamics of jointed structure. In *Nonlinear Structures Systems, Volume 1* (pp. 67-74). Springer, Cham.
- [2] Yuan, J., Fantetti A., Denimal E., Bhatnagar S., Pesaresi L., Schwingshackl C., Salles L. (2021) Propagation of friction parameter uncertainties in the nonlinear dynamic response of turbine blades with underplatform dampers *Mechanical Systems and Signal Processing* **156**: 107673.

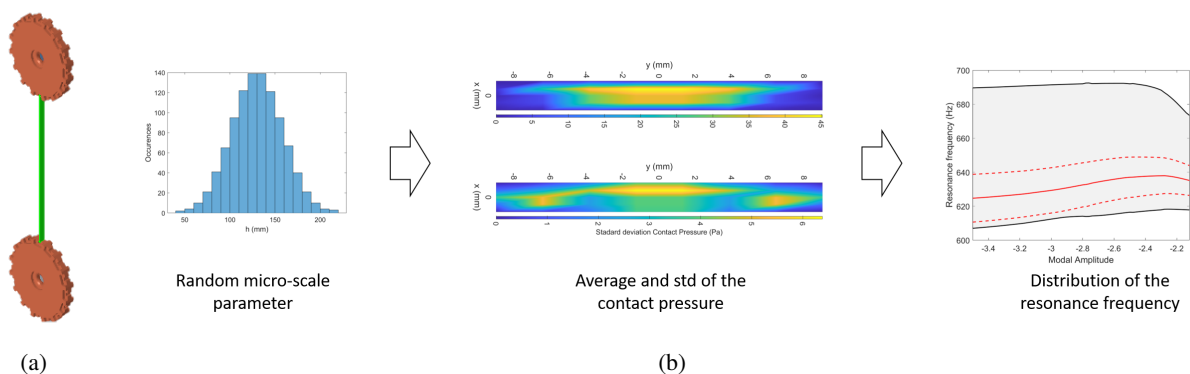


Figure 1: (a) FE model of the Dogbone rig (b) Multi-scale UQ process illustration