H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project: **Efficient nonlinear stochastic dynamics approaches for complex structural systems subject to natural hazards**

Dr Ioannis P. Mitseas

Principal Investigator: **Dr Ioannis P. Mitseas**

Reader-friendly title: **ESDA**

Scientific Area: **2, Scientific Field: 2.1.6**

Institution and Country: **H.F.R.I, Greece**

Host Institution: **National Technical University of Athens (NTUA), Greece**

Collaborating Institution(s): **Leibniz University of Hannover (LUH), Germany**

Project webpage (if applicable):

Budget: **185.470,00 €**

Duration: **36 months**

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Research Project Synopsis

Treatment of uncertainty when addressing real-world engineering problems has long been recognized as a topic of considerable importance, attracting researchers from a vast array of diverse fields. Typically, Monte Carlo simulation-based approaches constitute a rational basis for response system determination and reliability/risk assessment, accompanied, however, by a specific computational cost. Most structural systems are subject to natural hazards, such as earthquake and wind excitations, which exhibit strong variability in both the intensity and the frequency content. Clearly, this attribute necessitates careful consideration of the representation for this class of loads by rendering appropriately to efficient concepts for a consistent and rigorous stochastic characterization. Next, regarding the transmission of random vibration, a more pertinent representation of the system model requires the thorough consideration of the real mechanisms which determine the overall system behavior. In this setting, a suitable stochastic representation of the induced excitation in conjunction with nonlinear/hysteretic and non-classically damped system modeling provides a solid basis for the evaluation of system performance. Clearly, persistent nonlinear stochastic structural dynamics problems faced by engineers of practice are amenable to efficient and comprehensive solutions, harnessing the potential of advances in inelastic random vibration theory. The objective of this proposal is to explore and create the future pathways in these areas by fostering multi-disciplinary approaches across theoretical and practical disciplines. This effort will be a considerable step towards coupling advanced stochastic engineering dynamics with stochastic hazard modelling in conceptual agreement with contemporary code and guidelines provisions (e.g. Eurocode 8), leading to a paradigm shift in the way modern engineering systems work under the presence of uncertainties.

Project originality

The developments of this project concern mainly solving key questions of capturing the inherent stochastic nature of natural hazards and analyzing structures and systems under such loads considering complex nonlinear/hysteretic material behavior. These developments explore new pathways to capture uncertainty and imprecision in engineering analyses in a realistic form reflecting the nature of the available information as it typically appears in engineering practice. With these concepts, the proposed HRFI project leaves the constraints of traditional approaches behind and works towards closing the major gap between advanced stochastic engineering dynamics and contemporary design code provisions.

Expected results & Research Project Impact

The academic impact of this work is expected to be broad and multifaceted, since it lies in the intersection of structural engineering, applied mathematics and stochastic calculus. In addition, the proposed research will also have an impact on a societal level. Specifically,

- ***In the short term:***

This HFRI project involves collaboration with internationally well-recognized academic partners **in the fields of risk analysis, uncertainty quantification and stochastic analysis*****. In this setting, the project serves towards developing strong ties and strengthening the relationship between the National Technical University of Athens (NTUA) with some of the leading Universities worldwide (e.g. Leibniz University Hannover, Germany, Columbia University, USA).***

- ***In the long term:***

It is hoped that the scientific knowledge produced from this HFRI project will contribute towards enhancing the Greek economy via improving the structural engineering practice standards and via addressing challenges related to the engineering structures and infrastructure subject to severe natural hazards. This research will address important questions related to the complex nonlinear/hysteretic material behavior as well as the inherent stochastic nature of natural hazards.

The importance of this funding

The H.F.R.I supports academic actions of exceptional scientific quality for the benefit of society and science. Clearly, such actions have a strong positive impact on science in an international level and bring national academic institutions in prominent position regarding the generation and dissemination of the scientific knowledge and expertise.

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