MARIE SKŁODOWSKA-CURIE POSTDOCTORAL FELLOWSHIPS 2022

EXPRESSION OF INTEREST FOR HOSTING MARIE CURIE FELLOWS

HOST INSTITUTION

NOVA School of Science and Technology | FCT NOVA; UNIDEMI

RESEARCH GROUP AND URL

UNIDEMI, https://www.unidemi.com/

SUPERVISOR (NAME AND E-MAIL)

José Manuel Cardoso Xavier, jmc.xavier@fct.unl.pt

SHORT CV OF THE SUPERVISOR

J. Xavier is an Assistant Professor at the Department of Mechanical and Industrial Engineering (DEMI) at NOVA School of Science and Technology (FCT NOVA) of NOVA University of Lisbon (FCT NOVA).
J. Xavier is an integrated researcher member at the Research and Development Unit for Mechanical and Industrial Engineering (UNIDEMI). UNIDEMI received by the FCT-MCTES the evaluation of ``EXCELLENT''. Besides, J. Xavier has been collaborating with other external institutions namely LAETA/INEGI/UP, CITAB/UTAD and ISISI/University of Minho.
Since obtaining the PhD degree, J. Xavier has participated, as a researcher, in 10 projects with industry and 11 projects funded by national government agencies (e.g. FCT, Portugal2020, Ministerio de Economía y Competitividad, ES, EPSRC Fellowship, UK). He is currently a principal investigator in a FCT project with reference: PTDC/EMD-EMD/1230/2021. J. Xavier has published 85 papers in international peer-reviewed journals with an accumulated h-factor of 28(25) and with 2309(1883) total(independent) citations. Among them, 81 were published independently from the PhD supervisor and 29 were published as a senior (corresponding) author. Shorting the articles, 75 papers were published in top specialty peer-reviewed journals (quartile in category Q1/Q2). J. Xavier has published 4 book chapters and contributed with 1 didactic publications, among other (non published) academic resources for students. J. Xavier completed the supervision/co-supervision of 1/3 PhD (3nd cycle), 13/23 MSc students (2nd cycle) and 2 MSc ERASMUS student. Moreover, he is carrying out the supervision/co-supervision of 3/4 PhD and 2/3 MSc students. The PhD candidates are from NOVA SST, NOVA Medical School, Technical University of Madrid (ES), University of Aveiro, Universidade Federal Fluminense, Brasil.
He has been invited as member of juries of PhD and MSc thesis in Portugal, Europe (France, Spain, Italy) and Brazil. He has also been invited to international visits in the framework of research and projects. He is also a regular reviewer of international and national peer-reviewed journals. J. Xavier has been collaborating as membership of scientific, organizing committees and courses. He has been invited as chairman in section at different international and national conferences as well as figuring in scientific and organization committees. Moreover, he has been participating in COST Actions dealing with the wood, timber, wood-based products and X-ray computed tomography. Furthermore, efforts in transfer of technology from the research promoted or in which he has been involved were actively engaged.
Since his graduation in Mechanical Engineering, he had already started teaching as invited lecturer, namely by accumulating activities during MSc, PhD, post-doc (Ciência2018 FCT program) and as Invited Assistant Professor (Engineering Department of the School of Science and Technology in UTAD). In the meanwhile, as general duties and responsibilities in academia, he has been gaining experience in academic service and pointed as vice-director of the MSc course on Mechanical Engineering, ECT, UTAD (academic year 2018/19) and, more recently, as coordinator of the Master in Digital Advanced Manufacturing Engineering at NOVA SST.

5 SELECTED PUBLICATIONS

- Pereira, F.; Morais, J.; Xavier, J.; Dourado, N.; de Moura, M. Experimental evaluation of cohesive laws components of mixed-mode I+II fracture characterization of cortical bone.

Engineering Fracture Mechanics 268: 108493, 2022. DOI: 10.1016/j.engfracmech.2022.108493

- Valente, R.; Mourato, A.; Brito, M.; Xavier, J.; Tomás, A.; Avril, S. Fluid-structure interaction modelling of ascending thoracic aortic aneurysms in SimVascula. Biomechanics 2(2), 189-204, 2022. DOI: 10.3390/biomechanics2020016
- Filho, J.; Xavier, J.; Nunes, L. An Alternative Digital Image Correlation-Based Experimental Approach to Estimate Fracture Parameters in Fibrous Soft Materials. Materials 15(7):2413, 2022. DOI: 10.3390/ma15072413
- Henriques, J.; Xavier, J.; Andrade-Campos A. Identification of Orthotropic Elastic Properties of Wood by a Synthetic Image Approach based on Digital Image Correlation. Materials 15(2):625, 2022. DOI: 10.3390/ma15020625
- Pagaimo, F.; Fernandes, P.; Xavier, J.; Alves, O. New methodology to assess in vivo quality of motion in cervical spine. Clinical Biomechanics 82:105275, 2021. DOI: 10.1016/j.clinbiomech.2021.105275

PROJECT TITLE AND SHORT DESCRIPTION

Project title:
Image-based inverse identification methods to extract mechanical parameters of biological tissues

Short description:
UNIDEMI (Research & Development Unit for Mechanical and Industrial Engineering from NOVA School of Science and Technology) leads a research project, funded by Fundação para a Ciência e Tecnologia (FCT), designated “Fluid-structure interaction for functional evaluation of ascending aortic aneurysms: a biomechanical approach to clinical practice” (AneurysmTool PTDC/EMD-EMD/1230/2021).
This project aims to create a database of clinical and imaging exams, which will work as a basis for the development of advanced computational tools.
In addition, it is also intended that all units involved in this project contribute to the development of a digital tool capable of modeling the specific hemodynamics of the patient with thoracic aortic aneurysm. This tool should be able to proved evidence concerning current practices based on in vivo functional imaging analysis, as well as allow a personalised analysis for each patient with an aortic aneurysm but without indication for surgery.
Therefore, and as the last item on the agenda of this project, a validation will be carried out on the solidity of this digital tool, in order to prove its robustness as a clinical indicator and the effectiveness of its aid in stratification of the risk of disease progression, through the identification of patients who may benefit from early surgical treatment.
This working task aims at developing advanced inverse methods to extract the whole set of relevant material modelling parameters for the biological tissues from full-field measurements. Identification strategies will be firstly developed and programmed in a virtual integrated simulator, considering both the measurement and identification chains. The design space of constitutive parameters will be analysed based on finite element simulations coupled to both the measurement and identification kernels to produce robust error bounds. This is an essential step before working on experimental data to prove the robustness of the new methods. Hyperplastic constitutive laws typically available on commercial software such as ABAQUS and ANSYS or biomechanical finite element-oriented packages such as SimVascular, CRIMSON, and FEBio will be considered. Namely the well-known and accepted Holzapfel constitutive framework for arterial wall mechanics will be used. Data in the form of heterogeneous deformation, loading and geometric dimensions will be fed into advanced inverse identification strategies, ie. the Virtual Fields Method and the Finite Element Model Updating, to extract the whole set of relevant material modelling parameters for the biological tissues. A scripting algorithm coding either in Matlab or Python (Jupyter Notebooks) will be implemented to read and process the data in view of calculating the elasticity of the aorta. These algorithms will be open-source and shared with the community using a GitHub channel with a licence protocol. In the FEMU algorithm, the methodology needs a finite element model of the test itself. By integrating the full-field deformation measurements on the numerical modelling an updated identification strategy will be developed to measure the global stiffness of the structure. Global and local material properties will be estimated by implementing optimization strategies. A cost function can be written, for instance over the strain energy function, that minimizes the distance between numerical and experimental observations. This strategy, if successful, can

yield gradient mechanical properties generated by the natural structural variability of the tissue. In a second stage, data from pig tissue will be analysed in view of validating the methodology.
Expected results can be summarised as: (I) the elasticity of aorta tissue will be estimated from the advanced image-based strategies; (ii) the scripting routines and modules created in this task will be open-access and shared for further developments within the scientific community.

SCIENTIFIC AREA WHERE THE PROJECT FITS BEST*

Information Science and Engineering (ENG)

***Scientific Area where the project fits best** – Please select/indicate the scientific area according to the panel evaluation areas: Chemistry (CHE) • Social Sciences and Humanities (SOC) • Economic Sciences (ECO) • Information Science and Engineering (ENG) • Environment and Geosciences (ENV) • Life Sciences (LIF) • Mathematics (MAT) • Physics (PHY)