Marie Curie Doctoral position at:
- Università Degli Studi di Roma Tor Vergata (Italy)
- Ansys - Lyon (France)

ESR02 - The combined use of mesh morphing, force-feedback device and dynamic reduced-order models for achieving real-time hemodynamic solution over geometric changes

Keywords: biomechanics, Reduced-Order Models, Multi-Physics Simulation, real-time solutions.

General framework: 14 Early Stage Researchers (ESRs) will be offered doctoral positions as part of the MeDiTATe project, which is funded through the H2020 program: Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks – European Industrial Doctorate. The whole MeDiTATe project aims to develop state-of-the-art image based medical Digital Twins of cardiovascular districts for a patient specific prevention and treatment of aneurysms. The individual research projects of each ESR within MeDiTATe are defined across five research tracks: (1) High fidelity CAE multi-physics simulation with RBF mesh morphing; (2) Real time interaction with the digital twin by Augmented Reality, Haptic Devices and Reduced Order Models; (3) HPC tools, including GPUs, and cloud-based paradigms for fast and automated CAE processing of clinical database; (4) Big Data management for population of patients imaging data and high fidelity CAE twins; (5) Additive Manufacturing of physical mock-up for surgical planning and training to gain a comprehensive Industry 4.0 approach in a clinical scenario.
The work of each ESR, hired for two 18 months periods (industry + research) and enrolled in a PhD programme, will be driven by the multi-disciplinary and multi-sectoral needs of a multi-disciplinary research consortium (clinical, academic and industrial) which will offer the expertise of Participants to provide scientific support, secondments and training. Recruited researchers will become active players of a strategic sector of the European medical and simulation industry and will face the industrial and research challenges daily faced by clinical experts, engineering analysts and simulation software technology developers.
During their postgraduate studies they will be trained by the whole consortium receiving a flexible and competitive skill-set designed to address a career at the cutting edge of technological innovation in healthcare. The main objective of MeDiTATe is the production of high-level scientists with a strong experience of integration across academic, industrial and clinical areas, able to apply their skills to real life scenarios and capable to introduce advanced and innovative digital twin concepts in the clinic and healthcare sectors.

Description of the ESR project: The objectives of the project are related the combination of efficient mesh morphing, computational dynamic reduced order models (DROMs) and haptic devices in order to manage and solve hemodynamic simulations including fluid-structure interaction over geometric changes of tissues. The combined use of the three tools is expected to allow real-time solution, visualization and feedback in view of the Digital Twin MeDiTATe is planning to build. The assessment of this approach, vis-a-vis to Digital Twin, which is the ultimate goal of MeDiTATe, will be carried out and compared to the static results of ESR1. The first part of the project will be focused on the creation of the initial geometry model and the extraction of the surface mesh dataset. The use of ANSYS/Fluent and ANSYS/Mechanical will

be combined to RBF Morph and dynamic ROM Builder in order to prepare and solve a design of experiments scenario able to produce a ROM for the hemodynamic solution. In a second part, the definition and implementation of the communication with the haptic device will be addressed in order to enhance the interactive spatial creation and displacement of control points on the anatomical tissue giving a real-time force-feedback to the user. This part will be completed by the study of possible real-time interaction to the dynamic ROM to retrieve fast and reliable information about the hemodynamic simulations. The interaction is intended in two ways in order to actively update the geometry of the model and have a force-feedback (i.e. force and vibration) in order to enhance the interpretation of the results through an augmented probe (visual and haptic feedback).

Additional Information:
The ESR will be enrolled in the PhD programme of University of Rome Tor Vergata, Italy.
The PhD thesis will take place at two different places: (a) ANSYS Lyon (France) which is the global leader in engineering simulation; (b) University of Rome Tor Vergata (Italy) in the Department of Enterprise Engineering which is interested in shape optimization of structural parts, shape optimization using mesh morphing and CFD (automotive, nautical, naval, aeronautic), fluid structure interaction (reed valves, vessels, aircraft wings), vibrations of orthotropic plates, advanced use of RBF (image analysis of deformations, flow fields interpolation),large-scale high-fidelity numerical simulations of turbulent flows in complex geometric configurations, virtual prototyping and interactive simulations using virtual and augmented reality and haptic interfaces. A one-month secondment in Mines Saint-Etienne (France) is foreseen.

Benefits, salary and duration:
The selected candidate will receive a salary in accordance with the MSCA regulations for ESR. The gross salary includes a living allowance (€3,270 per month, subject to MSCA country correction coefficient, i.e. 104.4% for Italy and 115.7% for France), a mobility allowance (€600 per month), and a family allowance (€500 per month, if the researcher has family by the date of recruitment, regardless of whether the family will move with the researcher or not). The guaranteed funding is for 36 months (i.e. EC funding).

Eligibility criteria:
Applicants can be of any nationality and must hold a Master of Science degree (or equivalent) in engineering. They need to fully respect both eligibility criteria (to be demonstrated in the Europass CV): (a) Early-Stage Researchers (ESRs) must, at the date of recruitment by the beneficiary, be in the first four years (full-time equivalent research experience) of their research careers and have not been awarded a doctoral degree. (b) Conditions of international mobility of researchers: Researchers are required to undertake trans-national mobility (i.e. move from one country to another) when taking up the appointment. At the time of selection by the host organization, researchers must not have resided or carried out their main activity (work, studies, etc.) in Italy for more than 12 months in the 3 years immediately prior to their recruitment. Short stays, such as holidays, are not taken into account.

Candidate profile: Candidates with strong skills in mechanics (modeling and experimental) and biomechanics are expected. Motivation and interest in bioengineering applications is recommended. Knowledge of an object-oriented programming language is also welcomed. Excellent knowledge of written and spoken English is required.

How to apply: Send CV, cover letter, BSc and MSc degrees, and letters of recommendation to all the following recipients: biancolini@ing.uniroma2.it and michel.rochette@ansys.com.