Modélisation et Simulation Multi Echelle MSME UMR 8208

Open PhD position

Development of models and robust simulation methods for the propagation of ultrasonic waves in the presence of interphases

Context. The use of implants is now widespread in dental, maxillofacial or orthopedic surgery. However, the risks of failure, which are often very difficult to anticipate, still occur and can have serious consequences. The stability of the implants strongly depends on the quality of the newly formed bone tissue in an interphase between the bone-implant. However, existing techniques do not allow a reliable evaluation of the biomechanical properties of the interphase, nor to carry out a reliable clinical follow-up of bone healing. Non-destructive testing ultrasonic methods are very interesting for evaluating the properties of this interphase and following its evolution during healing. In clinical practice, the techniques associated with these methods aim to quantify the mechanical and micro-architectural characteristics of this interphase during the so-called osseointegration process.

Objective. The aim of this thesis is to develop and validate a mechanical model and numerical methods allowing to describe the interaction between the ultrasonic wave field and a rough surface of an implant which is totally or partially in contact with the bone tissue. We will first develop enhanced mechanical models to study the multiscale dynamic behaviour of the bone-implant interface. The problem will be then discretized for performing the numerical simulation of the ultrasonic wave propagation in the considered multi-physics and strongly heterogeneous medium. Employing high-order finite element methods will be considered. Model order reduction technique will also be applied for optimizing the direct simulation and inverse problem.

Strong collaboration with experimental scientists at CHU Nantes, as well as with applied mathematicians at the University Sorbonne Paris Nord will be expected in order to validate the proposed models and computational methods

Required skills. You hold or are enrolled in a Master degree in applied mathematics, mechanics or biomechanics exclusively. Your dynamism, your rigor, your sense of listening and your adaptability will make the difference. You have a solid multidisciplinary background with good knowledge in mechanical engineering, numerical simulation, signal processing, acoustics. You also have an attraction for the field of biomedical engineering, even no particular skill in this field is expected.

Work context. The PhD candidate will work within the Biomechanics team of the Laboratory of Multiscale Modelling and Simulation (MSME, UMR 8208 CNRS) at the Université-Est Créteil Val de Marne (UPEC), Campus Centre (metro Créteil-Université). The team is one of the recognized leaders in the research domain. This PhD programme will be part of the project DynImplant, funded by " Agence National de la Recherche " (ANR) in collaborating with collaboration with avec the University Sorbonne Paris Nord, CHU Nantes and the start-up Wave Implant (www.waveimplant.com). The PhD candidate may also have opportunities to participate to national/international conferences and/or benefit visiting doctoral fellowships in universities abroad during her/his PhD program.

Keywords. Computational mechanics; Ultrasound imaging; Reduced-order model; Machine Learning; Interphases; Implants;

Salary. The net salary will be about 1800 €/month. This salary may be complemented by assisting to some teaching tasks.

Contacts. Send your CV, motivation letter, note records of the 3 last years and recommendation letters (preferably before 30/04/2023) to:

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