Post-doctoral position in computational mechanics at the University of Luxembourg

The computational mechanics group of Prof. Stephane Bordas is searching for a post-doctoral researcher to work on one of the two following projects. The successful candidate will join a dynamic team (www.legato-team.eu) of computational engineers, mathematicians and computer scientists with plenty of European and worldwide connections.

Project 1: Mesoscale beam network model

Background: In the past, group members have developed several elastoplastic geometrically nonlinear spring models to predict the mechanical behavior of fabrics. In these models, each spring represents a yarn segment. Hence, they are defined at the mesoscale and are computationally prohibitive for engineering-scale computations. To overcome this issue, group members have reformulated the multiscale quasicontinuum (QC) method, which was originally only developed elastic models, to deal with dissipative models. A disadvantage of spring models for fabrics, and any type of fibrous material, is that quite some geometrical information, for instance regarding contact, must be lumped in the material behavior of springs.

Aim: We consider beams to conserve more geometrical information, especially regarding contact. This project therefore focuses on the formulation of an elastoplastic geometrically nonlinear beam model for fabrics in which contact between the beams is explicitly represented. The beam model will be calibrated on existing experimental data and compared to the spring model. If time permits it, the beam model will be upscaled using the QC method to allow engineering-scale applications. The QC method is a multiscale method that strongly resembles reduced-order modeling approaches, the only difference being that the QC method uses piecewise interpolation and ROM approaches global interpolation.

Project 2: Adaptivity for virtual-power-based QC methods

Background: The quasicontinuum (QC) method is a multiscale approach for discrete models. The method shows substantial similarities with reduced order modeling approaches, with the main difference that it uses piecewise interpolation instead of global interpolation. The piecewise interpolation has the advantage that reduced integration points can straightforwardly be determined, increasing benefits to the method.

The QC method was developed for (conservative) atomistic models, but group members have reformulated the method such that it can also be used for discrete dissipative models. We have furthermore experience with higher-order QC approaches and different approaches to select reduced integration points. Recently, we have experienced that for elastoplastic beam models adaptivity is required to obtain accurate results.

Aim: This project therefore aims to formulate and compare two adaptive procedures for QC approaches: adaptivity driven by a local physical quantity and goal-oriented adaptivity, whereby adaptivity is driven by the bounded accuracy of a quantity of interest. Goal-oriented adaptivity has the advantage that

remeshing is only applied to increase the accuracy of a given quantity, whereas the adaptivity driven by a local physical quantity may lead to more remeshing than is actually required for the result in which one is interested. On the other hand, goal-oriented adaptivity requires the solution of a dual problem to assess the influence of each part of the domain on the quantity of interest, adding computational efforts to the approach.

The group has formulations and implementations of several mesoscale models and associated (higher-order) QC methods and this project will focus on reformulating these such that both adaptive approaches are included.

Starting period: as soon as possible.
Duration: 1 year, which may be extended.
Salary: highly competitive
Background: Candidates with a PhD in computational mechanics and applied mathematics are encouraged to apply. Experience in one or more of the following fields will be appreciated:
- nonlinear FEM
- reduced order modeling
- adaptivity
- multiscale modeling

In mutual agreement both projects can be somewhat altered to meet the interests of candidates. Stephane Bordas will be the main supervisor and Lars Beex the daily supervisor. Please do not hesitate to contact stephane.bordas@gmail.com and/or l.a.a.beex@gmail.com if you are interested in one of the projects.

The positions will be embedded within the ERC RealTCut project
http://www.2020-horizon.com/REALTCUT-Towards-real-time-multiscale-simulation-of-cutting-in-non-linear-materials-with-applications-to-surgical-simulation-and-computer-guided-surgery%28REALTCUT%29-s2731.html
aiming at the generation of surgical training tools, in particular at the modeling and simulation of cutting of soft tissues in real-time.
For this, the team focuses on

1. Fast simulations in a clinical time scale
2. Understanding of tissue fracture from a mechanics viewpoint.