

Numerical modelling of knitted fabric

PhD or Post-doc, 2020

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Hosting Laboratory: ELAN team (INRIA and LJK, Grenoble), <https://team.inria.fr/elan/>

Practical details: PhD thesis (3 years) or post-doctoral position (1 year renewable), salary as defined in Inria scales. Start in fall 2020.

Context: Although it is made of almost inextensible yarns, knitted fabric exhibits an extremely stretchable mechanical behaviour, a highly desirable property in meta-material engineering. Furthermore, knitted fabric makes it possible to design arbitrarily shaped objects, either in 2D or 3D, with a predictable mechanical response. For these reasons, knitted fabric has recently gained a renewed and growing interest from industry and various fields of science – from physics to computer graphics. In physics, Poincloux and colleagues [6] have recently studied experimentally the tensile response of a model knitted patch in order to characterise relevant ingredients explaining the macroscopic mechanical behavior of knitted yarns, and started to derive a reduced continuum model. In graphics, complex simulations of 3D knitted fabric have been set-up for more than a decade [4, 5, 2], relying on a discrete element strategy where yarns and contacts between yarns are explicitly modelled. Only recently, a numerically homogenised model has been presented [7], which simulates knitted fabric as a thin elastic shell with a modified constitutive law fitted from simulated data. Although impressive, all these simulations have however never been validated against experiments, and the particular role of friction has never been investigated.

Objectives: The goal of the project is to develop numerical models for the study of knitted fabric. A first part of the PhD will be dedicated to the discrete element modelling of a model tricot, its validation against experiments, and the careful study of the role of friction. A second part will deal with the continuum modelling of the tricot using an analytical approach, which will be validated against the discrete element simulator. The project will involve collaborations with physicists to validate both models.

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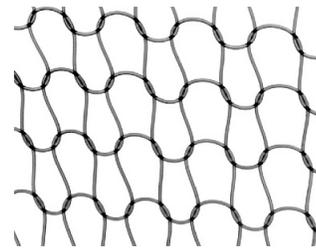


Figure 1: Loading experiment on a knitted fabric patch, by Poincloux et al. [6].

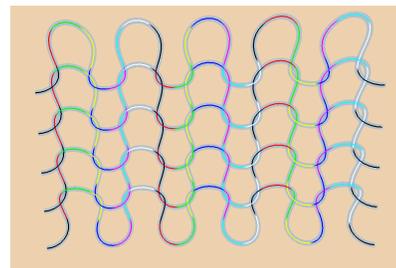


Figure 2: Discrete simulation of a knitted fabric patch, using [1] and [3].

Required Skills: For a post-doc, candidates must hold a PhD in any field among computing science / physics / mechanical engineering / applied mathematics, and candidates should have a proven research track record, demonstrated by publications in peer-reviewed journals in one or more of the above areas. For all candidates, good skills in numerical analysis (modelling, numerical discretisation of ODEs and PDEs, finite elements, optimisation) as well as in algorithmics and programming (C/C++, Python) are required. Curiosity and taste for applications in mechanics, physics and computer graphics would be appreciated.



Figure 3: Continuum simulation of knitted fabric, using numerical homogenisation [7].

How to apply Candidates should apply **before July 15, 2020** by sending an e-mail to Florence.Descoubes@inria.fr, Melina.Skouras@inria.fr, and Thibaut.Metivet@inria.fr. Applications will be examined progressively as they are received. The application should contain:

- For a PhD:
 - a cover letter outlining the motivation of the applicant
 - the list of the classes followed during master (M1 and M2) and the grades obtained
 - a detailed CV of the applicant, including (possibly) the publication list, scientific and computing skills, and interests.
 - one or several reference letters (from a professor, an internship advisor, etc.)
 - any other document that the applicant would like to bring attention to in her/his application.
- For a post-doc:
 - a cover letter outlining the motivation of the applicant
 - a copy of the PhD diploma, together with reviewing and defense reports
 - a detailed CV of the applicant, including the publication list, scientific and computing skills, and interests.
 - one or several reference letters provided (at least) by the PhD advisor(s), possibly also by an academic or industrial partner, or a scientific personality
 - any other document that the applicant would like to bring attention to in her/his application.

Keywords: Numerical modelling, analysis and simulation, mechanics of thin elastic rods, dry frictional contact, plates and shells, numerical and theoretical homogenisation.

References

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