Computational Design of Freeform Structures

MSc internship proposal, October 2018

Stefanie Hahmann, IMAGINE team, INRIA-LJK, Grenoble
Georges-Pierre Bonneau, Maverick team, INRIA-LJK, Grenoble

Contact : stefanie.hahmann@inria.fr

Context

Recent advances in digital fabrication and material science raise various exciting new research challenges in computer science with applications to product design, architecture, medicine and art. One of them relies on the fact that 3D printing technologies, coming along with increasing computational capabilities, nowadays allow to realize more complex geometries and even to control the deformation behavior. Similar research challenges originate from architecture or structural engineering where creative structural design is linked with material realization. A common approach is to mimic material and fabrication constraints by suitable *geometric representations*, which are more easily translated into numerical algorithms. Successful examples include developable surfaces as a geometric representation able to mimic behavior of materials such as paper, garments or thin metal.

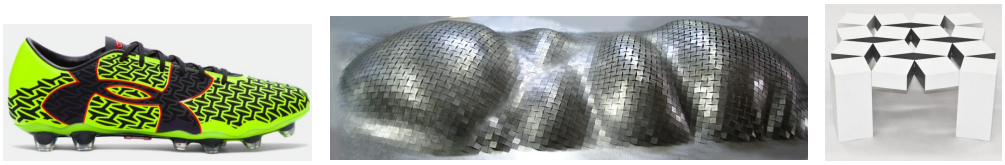

Figure 1: auxetic fabric (UnderArmor sportswear), xSurface in steel from H. Lavani, table from T. Cecil

Research Goal

In this internship we focus on a new class of surfaces, which is given by a geometric structure able to mimic deformable materials [2]. Figure 1 shows examples of such structures applied to sportswear, art and furniture.

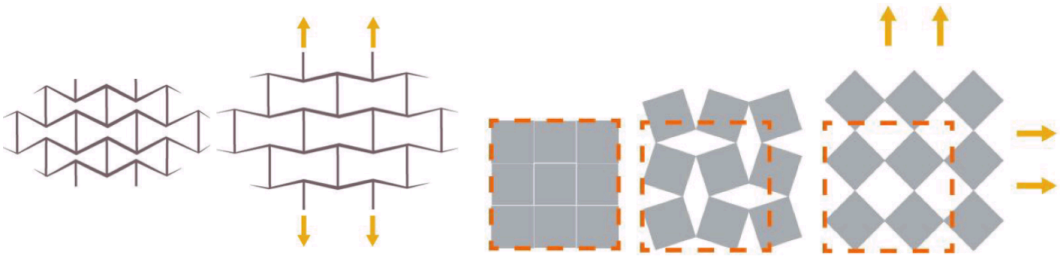

Figure 2: Two examples of structures, from [2]

The goal of this internship is to develop a 3D modeling system that allows to deform an initially planar shape into a doubly-curved shape only by using flat auxetic structures. These structures can stretch up to a certain extent, see Figure 2, even though their individual elements are rigid. Recent works focus on approximating a given geometry [1,3,4] or on characterizing mechanical and material properties [5,6].

Information for applicants and requirements

The internship will take place in the IMAGINE team at INRIA Grenoble, 655 avenue de l'Europe, 38330 Montbonnot. The candidate should have good knowledge in geometric modeling and numerical algorithms and solid experience in computer graphics programming.
Please send your complete CV to Stefanie Hahmann (stefanie.hahmann@inria.fr) and Georges-Pierre Bonneau (georges-pierre.bonneau@inria.fr). Feel free to contact Stefanie Hahmann for any further information about the internship.

References

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