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Design géométrique de meta-matériaux auxétiques

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Résumé

This paper is devoted to a category of metamaterials called auxetics, identified by their negative Poisson's ratio. Our work consists in exploring geometrical strategies to generate irregular auxetic structures. More precisely we seek to reduce the Poisson's ratio, by pruning an irregular network based solely on geometric criteria. We introduce a strategy combining a pure geometric pruning algorithm followed by a physics-based testing phase to determine the resulting Poisson's ratio of our structures. We propose an algorithm that generates sets of irregular auxetic networks. Our contributions include geometrical c haracterization of auxetic networks, development of a pruning strategy, generation of auxetic networks with low Poisson's ratio, as well as validation of our approach. We provide statistical validation of our approach on large sets of irregular networks, and we additionally laser-cut auxetic networks in sheets of rubber. The findings reported here show that it is possible to reduce the Poisson's ratio by geometric pruning, and that we can generate irregular auxetic networks at lower processing times than a physics-based approach.

PDF du papier sur HAL.

Référence: Georges-Pierre Bonneau, Stefanie Hahmann, Johana Marku. *Geometric construction of auxetic metamaterials.* (Eurographics 2021), Computer Graphics Forum 40, 2021.

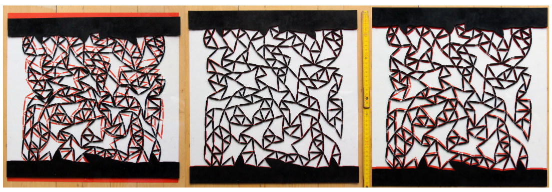

Figure 1: ***Experiment with laser-cut auxetic network.*** *Compression (left) and extension (right) of a laser-cut auxetic irregular network in rest state (middle) computed by our purely geometric process. Notice the horizontal, transversal contraction (left) and extension (right) characteristic of an auxetic behavior. The compressed network exhibits a Poisson's ratio* $\nu = -0.94$ *for an applied strain* $\varepsilon_y = -7.1\%$*. The extended network exhibits a Poisson's ratio* $\nu = -0.46$ *for an applied strain* $\varepsilon_y = +3.3\%$*. Strains are applied symmetrically to the top and bottom boundaries.*