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DESIGN OF CELLULAR MATERIALS FOR MULTISCALE TOPOLOGY OPTIMIZATION

Simona Perotto[*,1], Nicola Ferro[1], Daniele Bianchi[2], Raffaele Ferrante[2] and Marco Mannisi[2]

[1] MOX - Dipartimento di Matematica, Politecnico di Milano
Piazza L. da Vinci, 32, I-20133, Milano, Italy
{simona.perotto,nicola.ferro}@polimi.it
[2] Medere S.r.l., via Monasterace, 43, I-00118, Roma
{daniele.bianchi,raffaele.ferrante,marco.mannisi}@medere.it

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Cellular materials have been engineered in the last years to mimic the good properties characterizing biological systems (e.g., bones, honeycombs, sponges, wood), thanks also to the promotion of additive processes such as 3D printing. This has favoured the proposal of innovative methods for the design of new materials. In this context, topology optimization represents the reference mathematical methodology, in combination with other techniques, such as inverse and direct homogenization.

In this talk we present a flexible and efficient problem-specific multiscale topology optimization procedure in order to yield products that match prescribed requirements at the macro-scale, thanks to a suitable alternation of different microstructures into the design domain.
The design pipeline consists of two distinct phases. During the first one, we employ the recent algorithm microSIMPATY [1] to devise a dictionary of unit cells that target different physical goals and comply with given design constraints. MicroSIMPATY algorithm promotes the design of free-form layouts, thanks to the combination of homogenization techniques with the SIMP method and a customized selection of the computational mesh. As a second step, we use the newly-designed cells in the dictionary to topologically optimize the macroscopic structure. This goal is reached by automatically identifying the regions of the design domain where the different unit cells have to be allocated, in accordance with selected macroscopic goals and constraints.

The generic workflow is finally particularized to a medical context in a proof-of-concept setting, i.e., to the design of patient-specific insoles for the treatment of foot diseases.

REFERENCES

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