A COMPUTATIONAL APPROACH FOR MANUFACTURING OPTIMIZATION OF 3D PRINTED FLEXIBLE INSOLES

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Introduction

In recent years, innovative materials have been developed to mimic the lightweight and strong characteristics found in biological systems like bones, honeycombs, sponges, and wood. These materials are characterized by a porous microstructure that alternates between solid and void. At the same time, the emergence of innovative manufacturing techniques, such as 3D printing, has facilitated the production of cellular materials in various fields especially in healthcare [1,2] where the additive manufacturing is emerging as an efficient production method from different point of view (e.g., cost, environment) [3]. On the other hand, the 3D printing manufacturing can take a long time for production depending on material (e.g., rigid or flexible), infill pattern and printing parameters. The proposed study defines a computational approach based on FEM to optimize the infill pattern, the printing parameters and material distribution with the aim to reduce the production time.

Materials and Methods

A computational tool has been developed integrating a numerical homogenization and a topological optimization implemented in ANSYS Academic Research Mechanical. In detail, a computational homogenization has been implemented to simulate the mechanical properties of the infill of the insoles. Different infills have been investigated in terms of mechanical properties and printing performance (e.g., speed and accuracy). The calculated constitutive properties have been assigned to the insoles geometries and different loading scenarios have been analyzed regarding therapeutical and use framework. With the results of these structural simulations, several topology optimization analyses have been performed, aiming at minimizing the compliance of the frontal part of the insole, while reducing its mass under a specified threshold. The objective of this study was to find a possible distribution of mass that allows to minimize the material use and printing time while retaining an acceptable structural response during the insertion phase of the insole into the shoe.

Results

Since the aim of this work is to optimize the production of 3D printed insoles, the distributions of material are evaluated addressing different loading conditions. Nevertheless, the main result concerns the production time of the insoles. As an example, in Fig. 1 depicts the optimal material distribution for a loading condition replicating the insertion of the insole in the shoes.

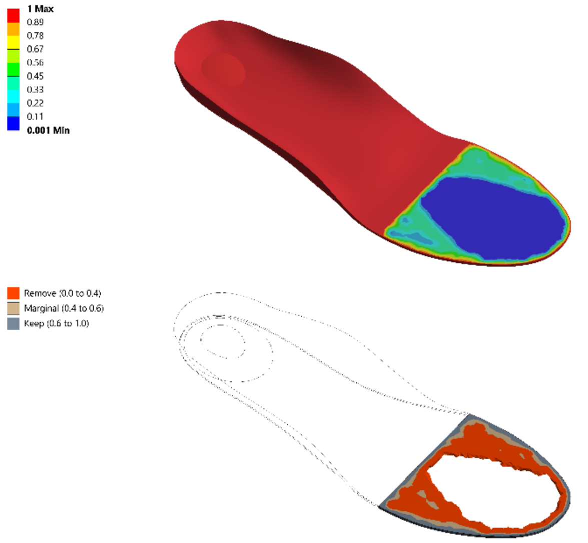

Figure 1: Optimal material distributions for a loading condition replicating the insertion of the insole in the shoes.

Discussion

In this work, a computational procedure is developed in order to investigate different infill patterns on the mechanical performance of 3D printed flexible insoles. Moreover, the printing time can be reduced optimizing the material distribution in the insoles. The developed computational tool can be used for different orthopaedic devices making more effective the 3D printing production.

References

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Acknowledgements

Daniele Bianchi and Cristina Falcinelli acknowledges the funding by the Italian Ministry of University and Research (MUR) within the PON "Ricerca e Innovazione" 2014–2020 (azione IV.6) - FSE-REACT EU.