Biomimetic Structural Optimization Method

New paradigm for shape and topology optimization

Michał Nowak

Poznan University of Technology, Division of Virtual Engineering, ul. Jana Pawła II 24, 60-965 Poznan, Poland
email: Michal.Nowak@put.poznan.pl

Abstract The trabecular bone adapts its form to mechanical loads and is able to form lightweight but very stiff structures. In this sense, it is a problem (for the Nature) similar to the structural optimization, especially the topology optimization. The structural optimization system based on shape modification using shape derivative [1] will be presented. Structural evolution during the structural optimization procedure is based on the adaptive remodeling of the trabecular bone and is independent of domain selection. In general the problem of stiffest design (compliance minimization) has no solution. If the volume of the object is increasing, the compliance is decreasing. Thus, in the standard approach to the energy based topology optimization the additional constraint has to be added. Usually the volume of the material is limited. But with such an assumption the optimization procedure does not include any criteria for stress. In case of the biomimetic approach presented here, the role of the additional constraint plays the strain energy density on the structural surface (which is between two assumed levels forming the insensitivity zone) and the volume or structural mass results from the optimization procedure. The variational approach to shape optimization in linearized elasticity is used in order to improve convergence of a heuristic algorithm. The method is enhanced to handle the problem of structural optimization under multiple loads [2]. The new approach does not require volume constraints. Instead of imposing volume constraints, shapes are parameterized by the assumed strain energy density on the structural surface.

REFERENCES

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Biography Prof. Michał Nowak graduated in Mechanics in 1989 and in Mechanical Engineering and Management in 1991 from Poznan University of Technology. In 1997 he received a PhD degree, in 2007 he received the Doctor Ph.D.Hab. degree. He is employed as Professor of Structural Mechanics at the Division of Virtual Engineering on Poznan University of Technology. His main research interests include: optimal design, topology optimization, aeroelasticity and biomechanics. He acts as a reviewer for many high-ranked international journals, editor of Journal of Mechanical and Transport Engineering and member of the Editorial Board of AIMS Bioengineering journal. He is also leading author of Cosmoprojector, structural optimization system coupled with aeroelastic analysis, developed within the EU FP5, EU FP7 and Polish National Science Centre research projects (cosmoprojector.eu).