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Localized Resolution Enhancement of Skeletal Images Based on Topology Optimization

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Abstract

Based on the hypothesis that bone is an optimal structure under the surrounding mechanical stimuli [1], it has been demonstrated that bone structures can be reproduced by topology optimization [2-3]. However, little attention has been paid to the feasibility of its biomedical applications. This paper proposes a novel method that can reconstruct high resolution (HR) skeletal images from low resolution (LR) clinical images, using topology optimization. Original clinical images such as quantitative computed tomography (QCT) scan data are first segmented for finite element (FE) analysis. Then, the localization of a target bone is conducted for the volume of interest (VOI) in order to enhance overall computational efficiency. Then, compliance minimization for the VOI is performed with a constraint for the bone mineral density deviation in order to preserve the subject-specific bone distribution. Numerical results demonstrate that the trabecular microarchitectures are reconstructed from LR QCT data for a proximal femur, thus exhibiting the potential of the proposed method in the translational medicine.

References

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