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Systematic measuring cortical thickness in tibiae for bio-mechanical analysis

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Abstract-

Background and Objective:
Measuring the thickness of cortical bone tissue helps diagnose bone diseases or monitor the progress of different treatments. This type of measurement can be performed visually from CAT images by a radiologist or by semi-automatic algorithms from Hounsfield values. This article proposes a mechanism capable of measuring thickness over the entire bone surface, aligning and orienting all the images in the same direction to have comparable references and reduce human intervention to a minimum. The objective is to batch process large numbers of patients’ CAT images obtaining thicknesses profiles of their cortical tissue to be used in many applications.

Methods:
Classical morphological and Deep Learning segmentation is used to extract the area of interest, filtering and interpolation to clean the bones and contour detection and Signed Distance Functions to measure the cortical Thickness. The alignment of the set of bones is achieved by detecting their longitudinal direction, and the orientation is performed by computing their principal component of the center of mass slice.

Results:
The method processed in an unattended manner 67% of the patients in the first run and 100% in the second run. The difference in the thickness values between the values provided by the algorithm and the measures done by a radiologist was, on average, 0.25 millimetres with a standard deviation of 0.2.

Conclusion:
Measuring the cortical thickness of a bone would allow us to prepare accurate traumatological surgeries or study their structural properties. Obtaining thickness profiles of an extensive set of patients opens the way for numerous studies to be carried out to find patterns between bone thickness and the patients’ medical, social or demographic variables.

Index Terms- Segmentation; Cortical thickness; Thickness measurement; Hounsfield units

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