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Segmentation procedure for the generation of a 3D model and solid replica of a human skull

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The present study describes a strategy to produce patient-specific skull base replica with realistic shapes, starting from radiological images. Several papers aim to highlight the clinical value of patient-specific three-dimensional (3D) models, obtained segmenting multidetector computed tomography (MDCT) images, for pre-operative planning in general surgery, for physician training and for didactics targets.

In this study, segmentation and 3D model generation were performed using a semiautomatic tool developed in the EndoCAS centre. The segmentation procedure is based on the neighbourhood connected region-growing algorithm that, appropriately parameterized for the anatomy of interest and combined with the optimal segmentation sequence, generates good-quality 3D images coupled with facility of use. Using a touch screen monitor, manual refining has been added to segment structures unsuitable for automatic reconstruction.

The goal of the present work consists in providing and visualizing quantitative geometrical and topological information on the anatomy of a cranium, starting from a MDCT dataset, and to develop a detailed solid replica that allow to improve the comprehension of anatomy and the dimensions of deep structures of a skull base. Anatomical structures of little size - e.g. foramen rotundum, foramen spinosum, lamina cribriformis, hypoglossal canal - were replicated in detail. Furthermore our 3D virtual model permits to well distinguish pneumatized bones; in particular nasal cavities and paranasal sinuses were minutely computer-generated.

We consider that our methodological approach to reproduce virtual and solid anatomical models can represent an useful didactic tool, both for undergraduate and postgraduate students.

Keywords: Segmentation, skull, 3D model, solid replica.