FROM BONE SEGMENTATION TO CUSTOMIZED IMPLANTS

Image Pyramid-based Noisy Evaluation in designing of customized implants

CHALLENGES: Health, demographic change and wellbeing

PRODUCTIVE SECTOR: Personalised healthcare

PROBLEM DESCRIPTION

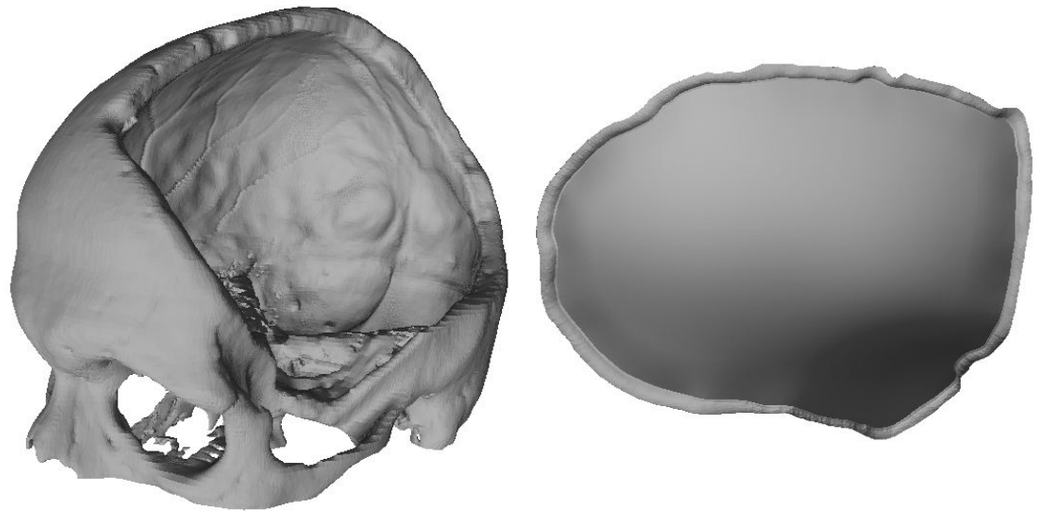
The company Varinex, having significant role in the development and domestic dissemination of individual and small-batch production methods based on 3D printing, was interested in designing and manufacturing of customized implants with time/ computational cost reduction.

CHALLENGES AND GOALS

- To generate automatic 3D bone segmentation and 3D reconstruction of the defect.
- To guarantee high accuracy of the methods in designing and manufacturing process.
- To reduce costs of the process in resources and in time.

MATHEMATICAL AND COMPUTATIONAL METHODS

For the extraction of bone structures from computer tomography images, an ensemble of segmentation algorithms with optimal parameter setting is applied, whose outputs are aggregated by some decision rule (e.g. majority voting). To reduce the computational costs and time, nearest neighbor image pyramid-based noisy energy function evaluation method is proposed for the local search technique simulated annealing (at different downscaling levels during the process). To ensure the convergence of SA, we have to apply a strategy to select the appropriate downscaling level (i.e. the resolution of the images) in each iteration to control the standard deviation of the noise according to the actual temperature. The reconstruction of skull defect is based on cubic Bezier curves, discretization of curvature, principal curvatures and torsion.



The result of automatic 3D bone segmentation (on the left) and the 3D reconstruction of skull defect (on the right, rotated view)

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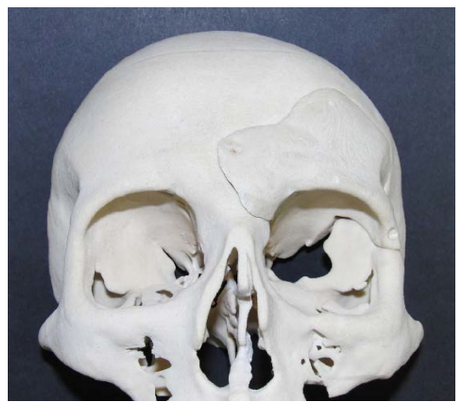
Results and Benefits

For the extraction of bone structures, variety of the models (ensembles of different segmentation algorithms with some decision rule) can be applied. To reduce the costs and computational time of the design process, nearest neighbor image pyramid-based noisy energy function evaluation method is provided. Besides a long successful cooperation with the Faculty of Medicine, Clinical Center, Varinex builds new collaboration with other research group of University of Debrecen on designing and manufacturing patient-specific implants.

The company has a computational methodology to design patient-specific implants and optimize the process.



The 3D printed skull model (on the left) and with mirroring-based implant (on the right)

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