

From BONE SEGMENTATION to CUSTOMIZED IMPLANTS

H2020 SOCIETAL CHALLENGES

Health, demographic change and wellbeing

The Industrial Problem

The company Varinex was interested in designing and manufacturing of customized implants and reducing the time and the computational cost of the process.

HEALTH SERVICES, PERSONALISED HEALTHCARE

UD Industrial Mathematics Research Group

Research
group



To tackle problems relating to the optimization of industrial processes including mathematical modeling, development of medical (decision support) systems

VARINEX Informatics Inc.

Company

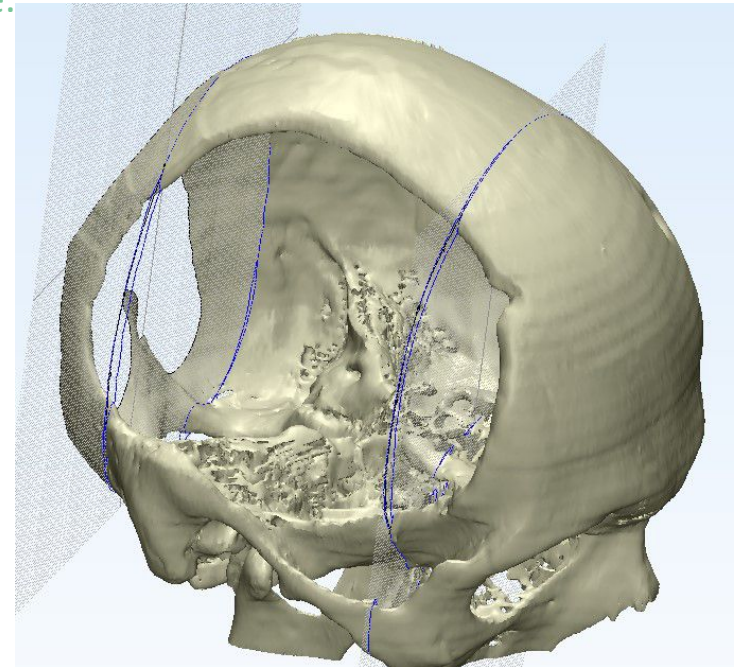
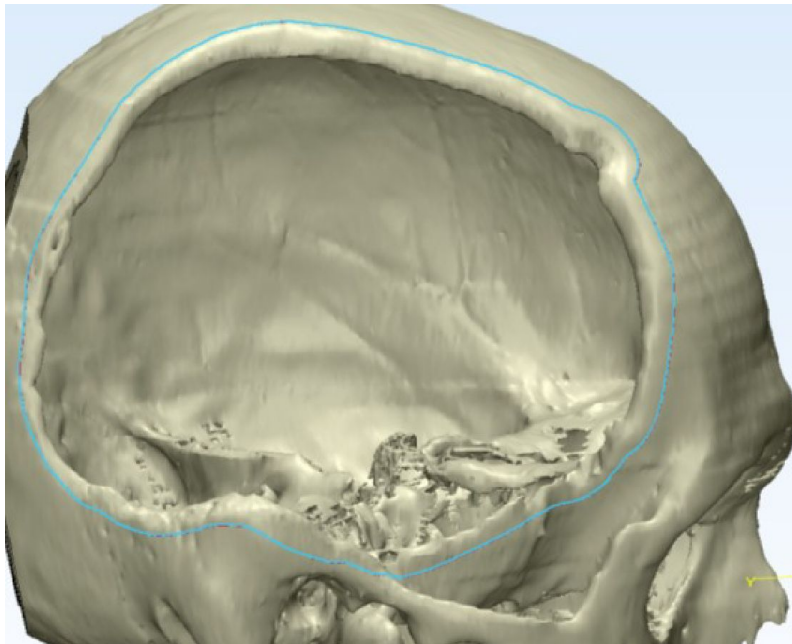


Rapid prototyping, development and domestic dissemination of individual and small-batch production methods based on 3D printing

From BONE SEGMENTATION to CUSTOMIZED IMPLANTS

Challenges & 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 provide other segmentation and reconstruction result for comparison.
- To reduce costs of the process in resources and in time.

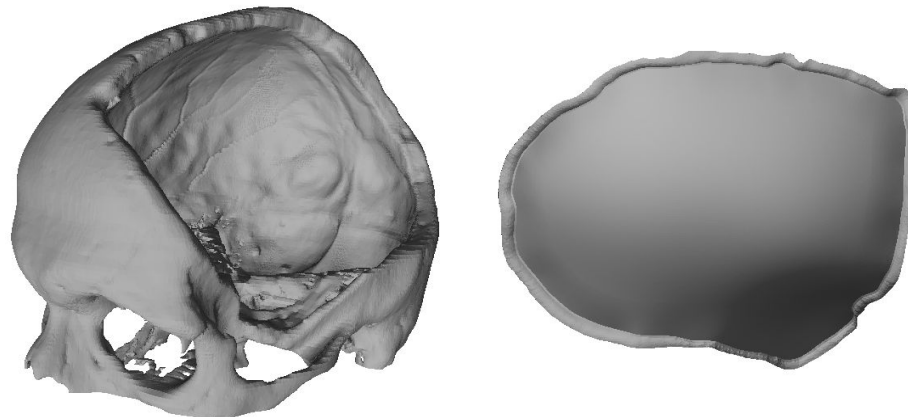


*3D bone segmentation with cranial defect margin
crestline and 3D reconstruction of skull defect (Mimics)*

From BONE SEGMENTATION to CUSTOMIZED IMPLANTS

Mathematical and computational methods and techniques applied

- 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 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 with a strategy how to select the appropriate downscaling level in each iteration.
- 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 (left) and the 3D reconstruction of skull defect (right, rotated view)

From BONE SEGMENTATION to CUSTOMIZED IMPLANTS

Results & Benefits to the company

- **Variety of the models** for the extraction of bone structures (ensembles of different segmentation algorithms with some decision rule)
- **Reduction of costs and time** of the design process
- Beside **a long successful cooperation** with the Faculty of Medicine, Clinical Center, **new collaboration** with other research group of University of Debrecen on designing and manufacturing patient-specific implants.



The printed skull model with mirroring-based implant

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