



Project Proposal

Project Management and Software Development for Medical Applications

General Info

Project Title: Skull CT visualization and matching.

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Project Abstract

In this project the student will develop an application to help the surgeons in two different steps of the neurosurgery. The first one will be the planning of the craniotomy based on a 3D reconstruction and visualization of the skull taken from the pre-operative 3D scan. The second one will be a comparison between the skull of the patient and a set of skulls obtained from a Statistical Shape Model to determine the best implant to fit in the patient's skull.

Background and Motivation

Cranioplasty is the procedure of repairing a cranial defect after a neurosurgical procedure. Sometimes the cut bony flap cannot be reinserted after the surgery and a patient specific implant needs to be designed, fabricated and attached to the patient's skull [Redfern 2007]. The whole procedure of design and fabrication of this patient specific implant takes between 2 or 3 weeks, so the patient skull remains open during this period increasing the risk of infection. An alternative solution is desirable, such as a general purpose implant which could be implanted on the patient's skull immediately after the surgery. For this purpose we aim at building a Statistical Shape Model (SSM) of the skull to obtain a set of common skull shapes that could be used to fabricate a set of implants that could be always available to the surgeon in the operating room.

We propose the development of a tool to compare the pre-operative Computed Tomography (CT) scan to a set of shapes previously generated using a Statistical Shape Model (SSM).

Student's Tasks Description

The project will be developed in cooperation with our clinical partners from the neurosurgery department of the Klinikum Rechts der Isar: MD Jens Lehmborg and MD Ehab Shiban. The student's first task will be to transfer and preprocess the CT data provided by the surgeons of the Klinikum Rechts der Isar. This includes preprocessing and segmentation of the skull.

After that the objective will be to develop an application with a Graphical User Interface (GUI) to help the surgeons in two different tasks:

1. Visualize the 3D reconstruction of the skull prior to the surgery to plan the craniotomy and estimate the skull shape after the procedure.
2. Compare the skull shape to a set of templates built using the statistical shape model to help the surgeons in the process of deciding which of the templates better fits the patient skull.

Technical Prerequisites

- Programming experience in MATLAB or C++ required.
- Experience in the design of Graphical User Interfaces is also desirable.

Administrative Info

Working Time: 8 hours p/week

Project Location: Garching Forschungszentrum. The student should also meet periodically the surgeons in Klinikum Rechts der Isar.

Required Equipment: Personal computer.

Please send the completed document to us (Ralf.stauder@tum.de) before the project proposal deadline, April 8th. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in the case of acceptance.



Timeline and Milestones

13 May – Dataset preparation.

10 Jun - Delivery of the tool demo for skull CT visualization and manipulation to the project supervisor.

18 & 19 Jun – Intermediate Project Presentation and Demo.

12 Jul – Delivery of the final application and Graphical User Interface. The application should be able to compare the patient skull CT with the skulls generated using a statistical shape model.

16 & 17 Jul – Final Project Presentation and Demo.

References

- Redfern, Pülhorn. Cranioplasty. *Advances in Clinical Neuroscience*. Volume 7. Nr.5. (2007)
- Lüthi, M., Albrecht, T., & Vetter, T. (2009). Building shape models from lousy data. In *Medical Image Computing and Computer-Assisted Intervention–MICCAI 2009* (pp. 1-8). Springer Berlin Heidelberg.
- Tilotta, F., Richard, F., Glaunès, J. A., Berar, M., Gey, S., Verdeille, S., ... & Gaudy, J. F. F. (2009). Construction and analysis of a head CT-scan database for craniofacial reconstruction. *Forensic Science International*, 191(1-3).