nano-tera.ch
swiss scientific initiative in health / security / environment systems

HearRestore RTD 2014

FNSNF

Strategies for Head Movement in CT Imaging

Ping Lu[1], Tom Williamson[2], Nicolas Gerber[2], Brett Bell[2], Stefan Weber[2], Mauricio Reyes[1]

[1]Institute for Surgical Technology and Biomechanics, University of Bern, Bern, Switzerland

[2]ARTORG Center for Biomedical Engineering Research, University of Bern, Bern, Switzerland

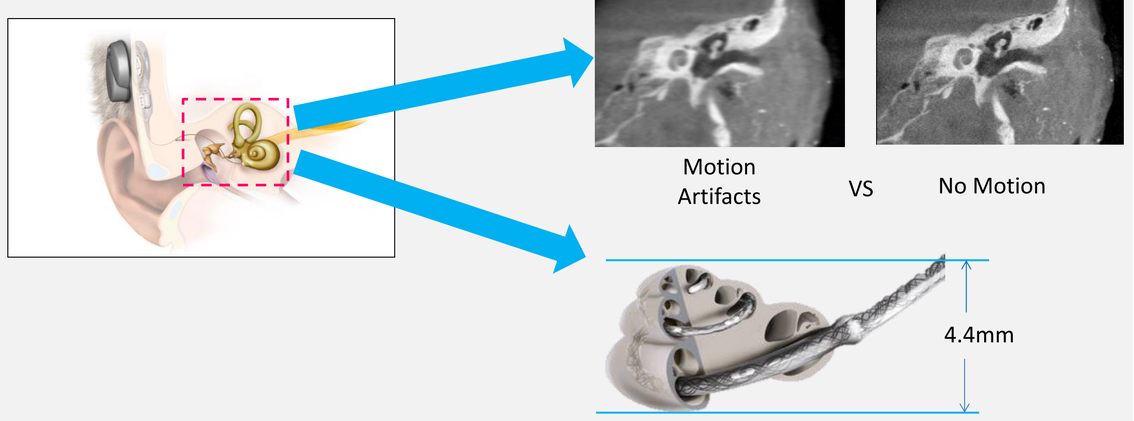
b UNIVERSITÄT BERN

Introduction

Cochlear implantation can help people who suffer from hearing loss to restore hearing.

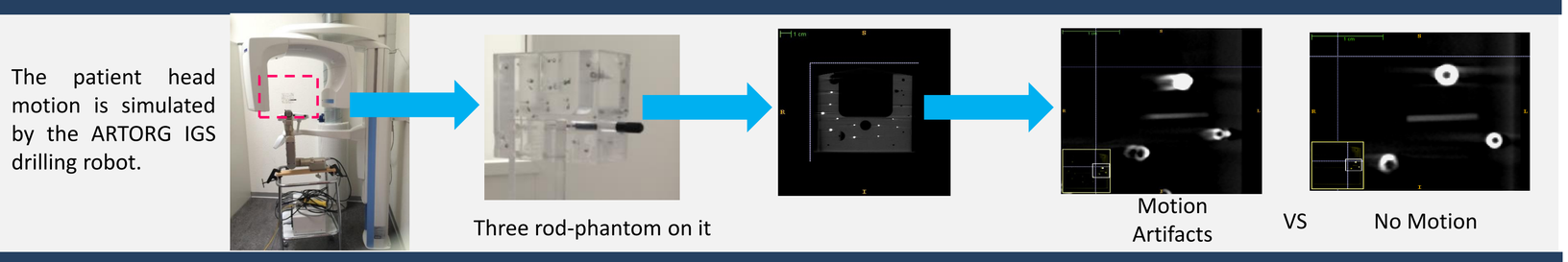
A micro-IGS (Image Guided Surgery) approach has been proposed to reduce the invasiveness and provide a more repeatable outcome. A surgical drill should pass through a safe path without penetrating any critical structure, such as the facial nerve, the chorda tympani, the external auditory canal wall, and ossicles. One challenge is to improve the quality of segmenting critical structure from CT scan, ensuring high repeatability.

The CT scanning image may be influenced by head movement. The blurred CT image may lead to suboptimal surgical planning, and hence, to the cochlear trauma and damage any critical structure.



Aim

In this work we aim at estimating patient head movement; determine data reliability; and find the amount of motion considered as acceptable for cochlear imaging.



Materials

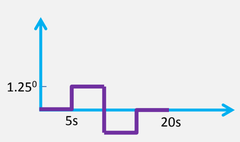
- ❑ Phantom with implanted fiducial screws and implanted rod-phantom
- ❑ Planmeca 3D CBCT max imaging system
- ❑ ARTORG IGS drilling robot

The motion patterns we have scanned

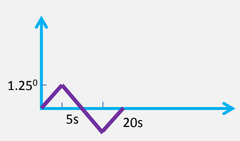
- ❑ No motion
- ❑ Sudden motion
  degree: 0.75, 1.25, 2.50, 5.00
- ❑ Continuous motion
  degree: 0.75, 1.25, 2.50, 5.00

Four rod-phantom

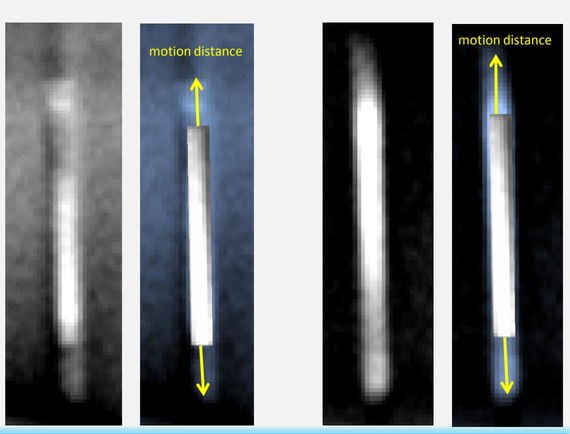
No motion



sudden motion

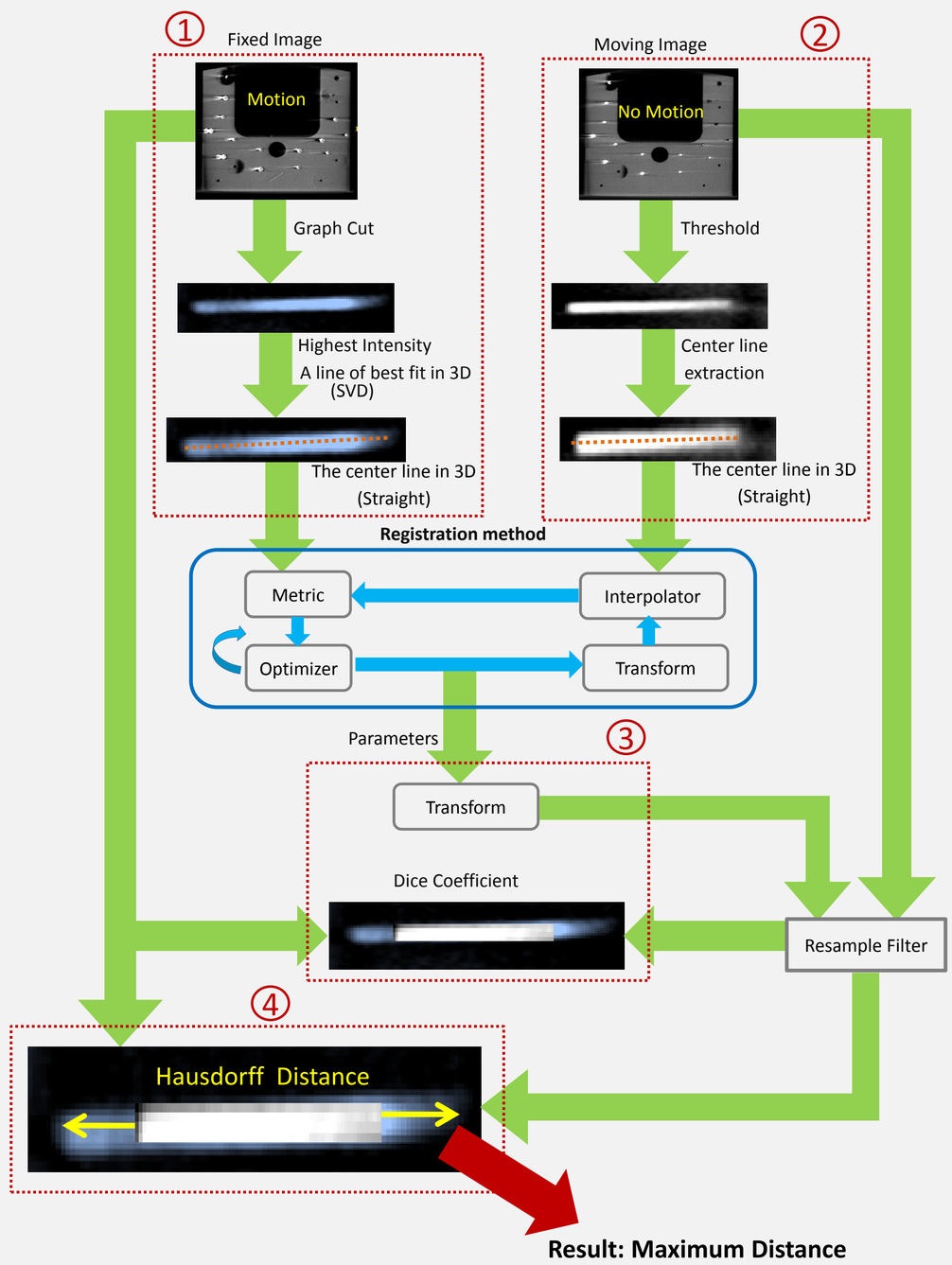


continuous motion



Stauffacherstr. 78 CH-3014 Bern
ping.lu@istb.unibe.ch

Pipeline & Methods



① **Method for CT Image with motion**

Graph Cut

Highest Intensity

The highest intensity represents the center pixel of the phantom with motion.

$$I = 0.95 * \max(I_{image})$$

0.95 is a parameter obtained heuristically.

A line of best fit in 3D space via eigen analysis

② **Method for CT Image without motion**

Threshold

On each image make a threshold for each known intensity (0, 400, 800, 1200) and perform manual corrections if needed.

Distance Map

③ **Registration Method**

Metric (Dice Coefficient)

Transformation

There is some angle between these two center lines at sometimes.

The transformation matrix will help to solve distance between them.

④ **Hausdorff distance**

Find the largest distance from the boundary of the phantom without motion to the boundary of the phantom with motion.

Acknowledgements

This research is funded by Nano-Tera.ch, Scientifically evaluated by the SNSF, Financed by the Swiss Confederation.