



Virtual reality in medicine

Biomedical Technologies in Diagnostic and Therapy
Summer Term 2019

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Overview

- What is virtual reality'?
- Digital Imaging
- Navigation
- Virtual Endoscopy
- Laparoscopy
- Robotic surgery
- Virtual reality training simulation

What is virtual reality?

“Virtual reality (VR) is an experience taking place within a simulation, which can be similar to or completely different from the real world.” – wikipedia.com

- Immersion in a projection with eyes, ears and “motion”

What is virtual reality?

VR-Device consisting of **three main components**

- **Base station** - Orientation/tracking of VR-user (4m x 4m up to 10m x 10m)
- **Head-mounted device** carrying
 - Display up to 1440 x 1600 pixels per eye, at 90 Hz
 - Camera – depth perception avoiding collisions in real world
 - Sound module /Microphone
 - G-sensor/Gyroscope – correlating head movements with the projection
- **Controller** – tracking movements to a fraction of a millimeter

Requirements for professional use

- Sufficient accuracy in position and orientation
- Low offsets between reported and actual position
 - orientation in the tracking space
 - accurately simulating the motion of the observer through a virtual space.
- Low latency – response time to user's actions

[Vestibular system](#)

Risks for users

- Oscillopsia – mismatch between visually and vestibular sensed head motion leads to nausea
 - User expects viewed world to remain stationary during head movements
- High latency → Unstationary VR-environment → mismatch visual vs. vestibular system
- Eyestrain

[Vestibuläres System - https://eref.thieme.de/media#/2343785/ebook_2343785_SL87949116/im2343694](https://eref.thieme.de/media#/2343785/ebook_2343785_SL87949116/im2343694)

[Schünke M](#), [Schulte E](#), [Schumacher U](#) et al. [13.22 Vestibuläres System](#). In: [Schünke M](#), [Schulte E](#), [Schumacher U](#) et al.,

Hrsg. [Prometheus LernAtlas - Kopf, Hals und Neuroanatomie](#). 5. Auflage. Stuttgart: Thieme; 2018. doi:10.1055/b-006-149644

virtual reality *in anatomy?*!

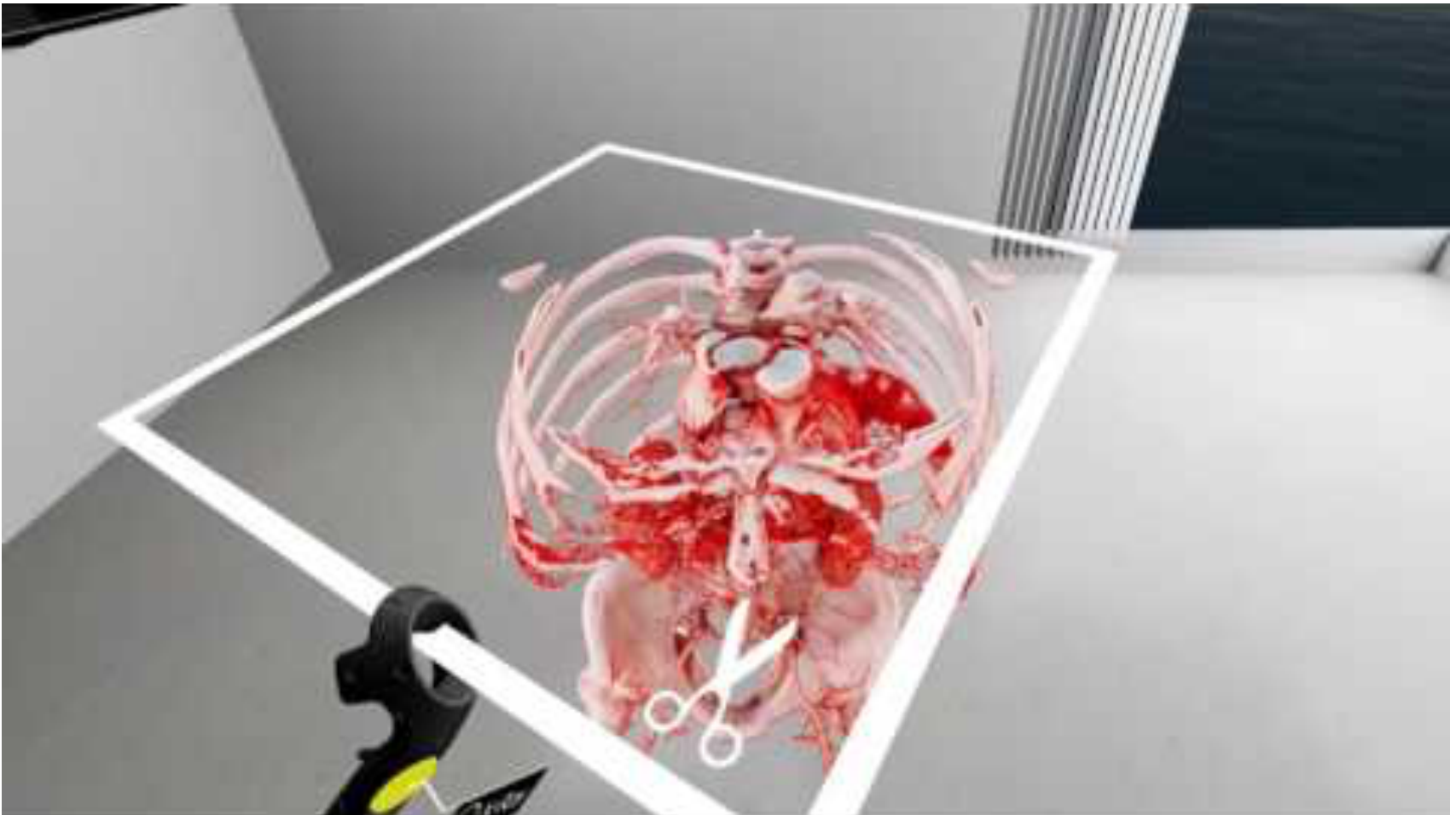
virtual reality *in medicine* started with digital imaging

Digital geometry processing is used to generate a three-dimensional image of the inside of the object from a large series of two-dimensional radiographic images taken around a single axis of rotation.

The same can be done with spatial information obtained in a magnetic field...

3D reconstruction → virtual reality

MIRACLE Project – Univ. Basel, Switzerland: Diagnostics and Surgical Planning

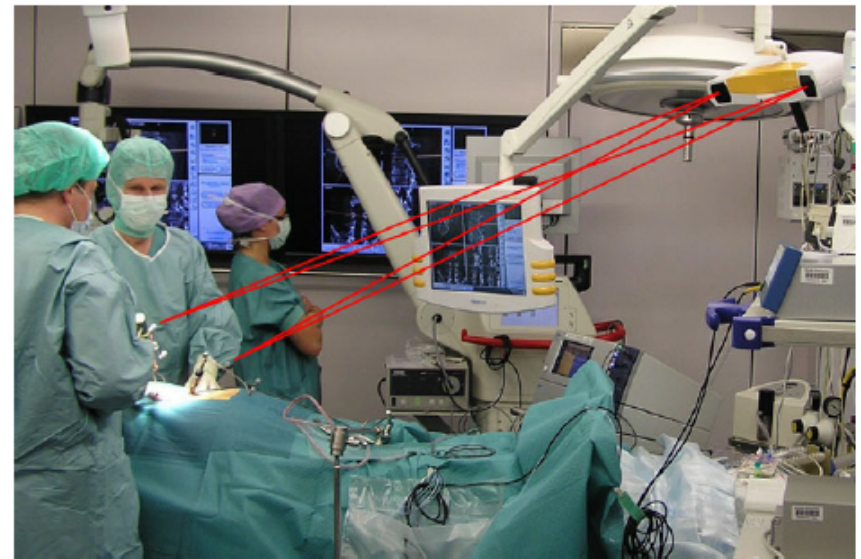
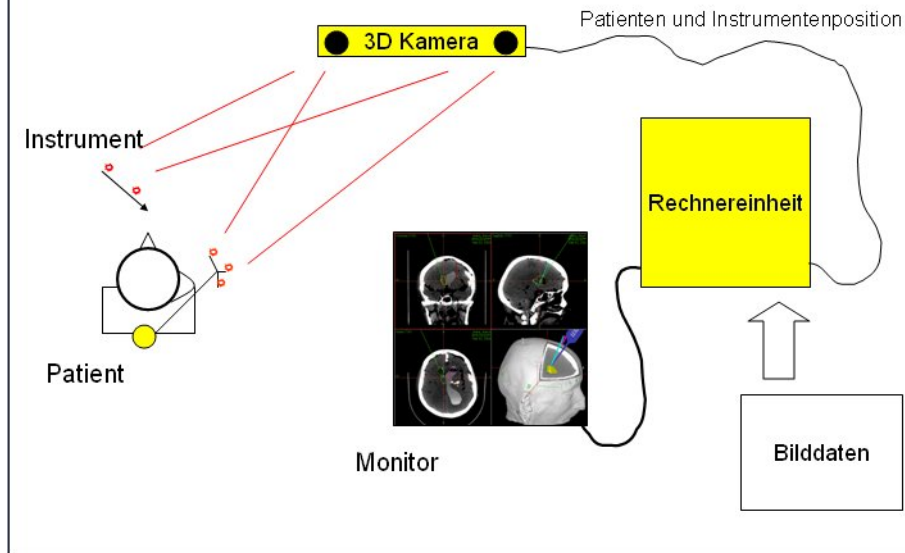


MIRACLE Project – Univ. Basel, Switzerland: Diagnostics and Surgical Planning

Surgical planning

- Volume rendered images in real time
 - Enhanced depth perception due to shadows by lamps in OR
- Complex/multiple bone fractures
- Complex tumor growth
- Automated postprocessing of radiological data

Technik der Neuronavigation



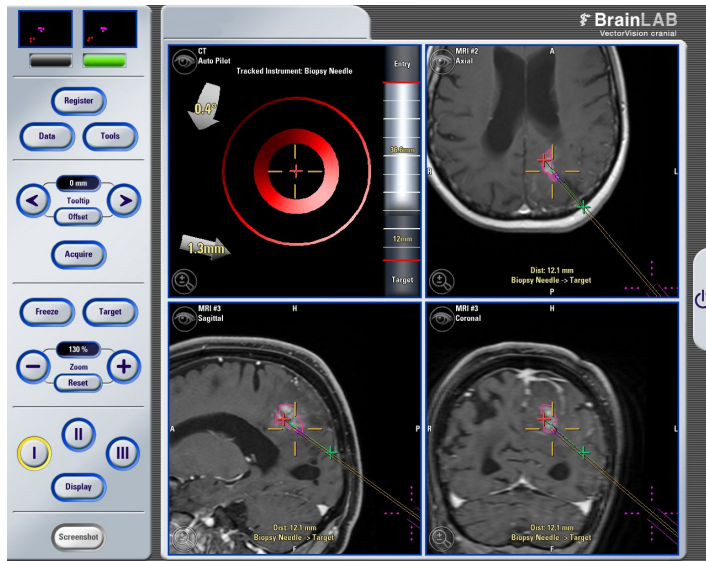


Fig. 6 Intraoperative imaging of the future with a portable, multi-slice CT scanner tightly integrated with navigation optimized for use in surgery. Copyright: Brainlab AG

from:

Mezger U, Jendrewski C, Bartels M. **Navigation in surgery.** Langenbecks Arch Surg 2013; 398: 501-514

Preparations in OR – Patient

- Nonsterile frame is mounted on patient's head
- CT-scan of patient with frame for alignment and fusion of MRI and CT data
- MRI data is needed to locate the targeted nucleus in the deeper parts of the brain

Summerterm 2019 Parkinson Disease: Deep Brain Stimulation – online soon

<https://www.sectio-chirurgica.de>

Preparations in OR – Sterile frame is prepared by the surgeon

- Frame contains a coordinate system
- The needle for puncturing is mounted on the frame

Summerterm 2019 Parkinson Disease: Deep Brain Stimulation – online soon

<https://www.sectio-chirurgica.de>

Preparations in OR – Placement of electrodes under guidance of fused CT and and MRI images

Summerterm 2019 Parkinson Disease: Deep Brain Stimulation – online soon

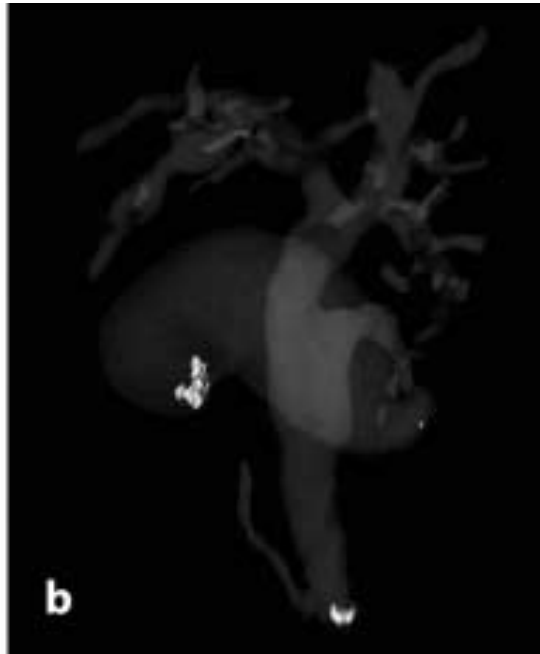
<https://www.sectio-chirurgica.de>

Preparations in OR – Testing of electrodes

Summerterm 2019 Parkinson Disease: Deep Brain Stimulation – online soon

<https://www.sectio-chirurgica.de>

Virtual endoscopy



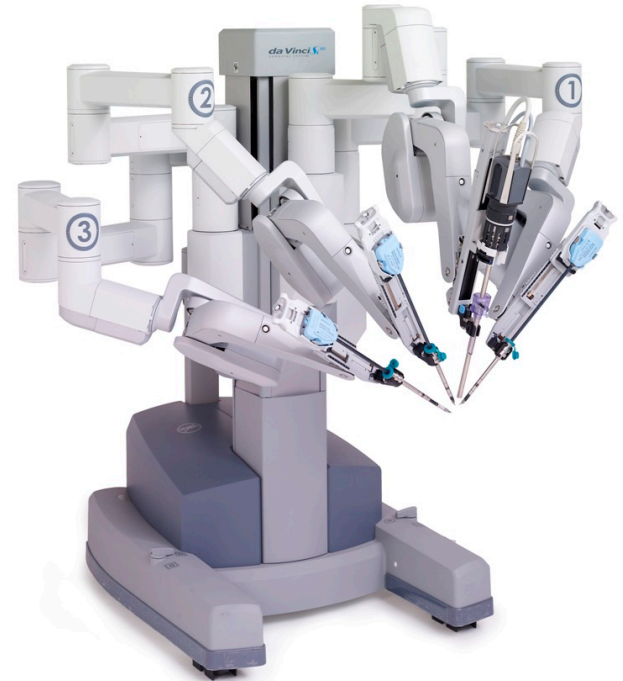


- Laparoscopy is ,semi-virtual‘
- no direct sight of the operative field or instruments
 - but: display of reality
 - haptic feedback !



Virtual reality in medicine





Virtual medicine 3.0: Robotic surgery

Virtual reality in medicine



Virtual reality in teaching

Virtual reality in teaching

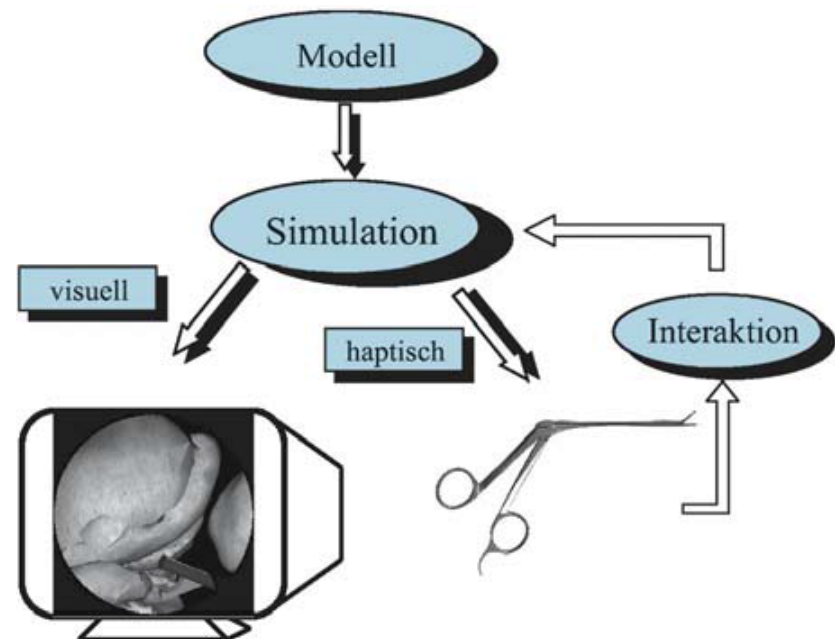
Virtual reality in teaching

[Sectio-Chirurgica WS 2018/17 - Clivus Chordoma](#)

Virtual reality in medicine



full virtual reality
as a tool for training



Conclusion:

Virtual reality has found a place in medicine and many uses:

- Digital Imaging
- Navigation
- Robotic / Robot-assisted Surgery
- Laparoscopy / Arthroscopy / Endoscopy
- Virtual endoscopy
- Simulation for training and education

Challenges:

Not all senses are covered by the immersion into the virtual reality

- Risk of nausea
- Haptic feedback: Reduced training effect and precision

Thank you for your attention.

Dr. med. Andreas Wagner

Basis of presentation kindly provided by
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