MRI Guided Mixed Reality for Breast Conserving Surgery
- Preliminary Setup

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Breast Conserving Surgery - Lumpectomy

• Early stage breast cancer treatment

• removal of abnormal or cancerous tissue with an extra margin

• followed by radiation therapy to reduce recurrence of breast cancer

• lumpectomy is shown to be as effective as mastectomy while maintaining the appearance of the breast
Cons - Lumpectomy

Negative margin

Positive margin

http://www.clrcut.com/
Cons - Lumpectomy

Original Investigation

Repeat Surgery After Breast Conservation for the Treatment of Stage 0 to II Breast Carcinoma
A Report From the National Cancer Data Base, 2004-2010

Lee G. Wilke, MD; Tomasz Czechura, MPH; Chih Wang, PhD; Brittany Lapin, MPH; Erik Liederbach, BS; David P. Winchester, MD; Katharine Yao, MD

- Database of 316,114 patients with Stage 0 to II breast cancer
- **23.6%** of lumpectomy patients underwent a second surgery
- Adds cost and anxiety, delays adjuvant therapy and reduces cosmesis
Cons - Lumpectomy

- 37.9% of repeat surgeries were completion mastectomy
- 56.4% of the tumors in these completion mastectomy patients had < 2 cm tumors
- This is about 5600 avoidable mastectomies/yr
Current Breast Imaging Techniques

13 mm cluster of microcalcifications

6 mm IDC, 8mm IDC and 40 mm DCIS

Mammography

MRI

http://www.cancer.gov/

http://weill.cornell.edu/mri/MRI/Chest/breast_mass_mri.htm
Wire Localization
for non-palpable tumors

Pre-localization

Post-localization

• removed 4mm IDC
• 30 mm DCIS
• close margins
• mastectomy
• 3mm DCIS at biopsy site
Goal

To enable surgeons to do more definitive surgeries by

• acquiring MR images in close to surgical position - supine instead of prone breast MRI

• Projecting these MR images on to the patient for surgical planning
Prone vs. Supine Breast MRI
Microsoft Hololens

Sensor fusion.

Microsoft Hololens has advanced sensors to capture information about what you’re doing and the environment you’re in.

Advanced optics.

See-through holographic high-definition lenses use an advanced optical projection system, generating multi-dimensional full-color images with very low latency so you can see holograms in your world.

Custom holographic processing unit.

The HPU is custom silicon that processes a large amount of data per second from the sensors. Microsoft Hololens understands gestures and where you look, and maps the world around you, all in real time.
Hololens - Mixed Reality
MR Markers for Registration

Kevin Kennedy, Microsoft

Jung Hwa Bae & Chris Ploch
Dept. of Mechanical Engineering

3D MRI
Phantom MRI Data

https://wiki.cancerimagingarchive.net/display/Public/QIN+Breast+DCE-MRI
Deformable Registration

Before

Phantom-mask
MRI mask

After

https://www.slicer.org/
Segmentation

Warped dataset

Tumor

Chest

Skin

http://www.itksnap.org/
Next steps

• How accurately do we perceive these ‘holograms’?
Next steps

• Experiments in normal volunteers
Acknowledgments

Microsoft
Lewey Geselowitz
Kevin Kennedy
Peter Vale
Kevin Collins

Department of Mechanical Engineering
Jung Hwa Bae
Chris Joseph Ploch
Mark Cutkosky

Brady Quist
Steffi Perkins
Hans Weber
Riccardo Stara