

XRDC

Mixed-Reality Guidance for Medical Procedures

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and (by courtesy) Electrical Engineering and Bioengineering
Stanford University

Stanford MEDICINE Radiology

XR DEVELOPERS CONFERENCE 2018 | October 29-30, 2018 #XRDC18

Disclosures

- Research Support:
 - GE Healthcare, Philips, Microsoft
- Most applications in this presentation are not approved by the FDA*

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Introduction - You?!

- Programmers or Designers?
- Business Leadership?
- Healthcare?
- Medical Doctors?

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Introduction - Stanford University

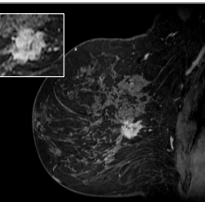


- 17,000 Students (undergrad + grad)
- Engineering, Computer Science, Medicine

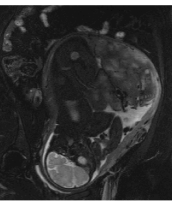
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Introduction - MRI Research

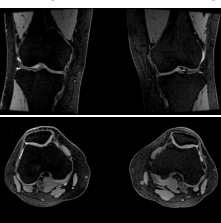
MRI = Magnetic Resonance Imaging



Breast MRI
Twice as sensitive
as mammography



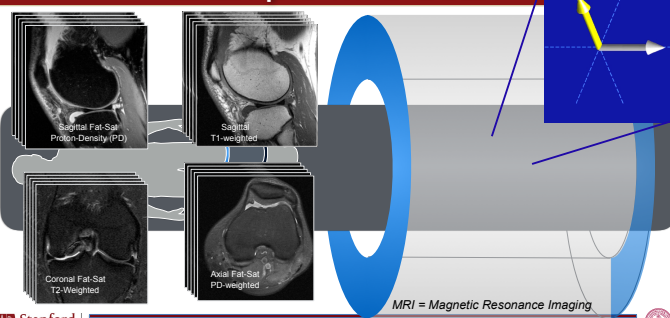
Fetal / Pediatric
Avoiding X-rays in
infants & children



Fast Knee Scans
5-min complete assessment

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Example MRI Scan



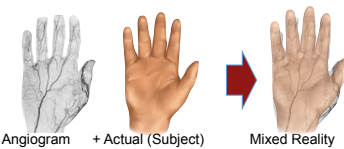
MRI = Magnetic Resonance Imaging

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Why Mixed Reality?

Mixed-Reality

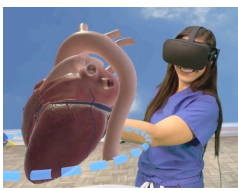
- Information/Images on Patients
- Planning, Guidance, Assessment



Angiogram + Actual (Subject) → Mixed Reality

Virtual-Reality

- Immersive power!



Stanford Virtual Heart Project

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IMMERS @ Stanford

Incubator for Medical Mixed and Extended Reality at Stanford



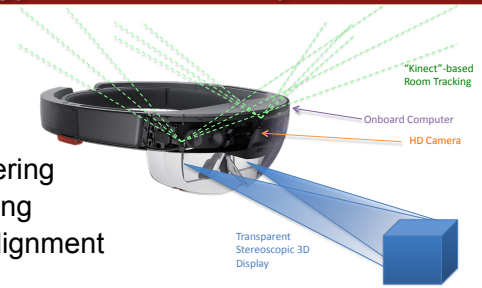
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Outline: Medical Applications

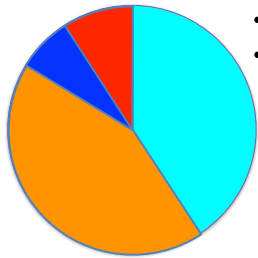
- Breast Surgery
- Medical Education
- Needle Guidance
- Orthopedic Surgery
- Brain Procedures
- Other Surgery

Technology: Mixed-Reality Headsets

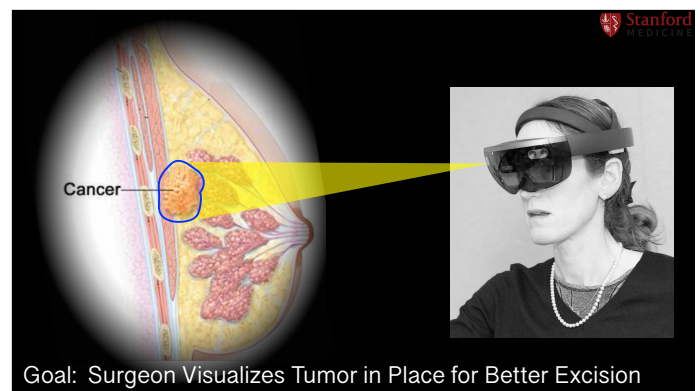
- Stable Rendering
- Object Tracking
- Perceptual Alignment (real+virtual)



Breast Surgery: Motivation



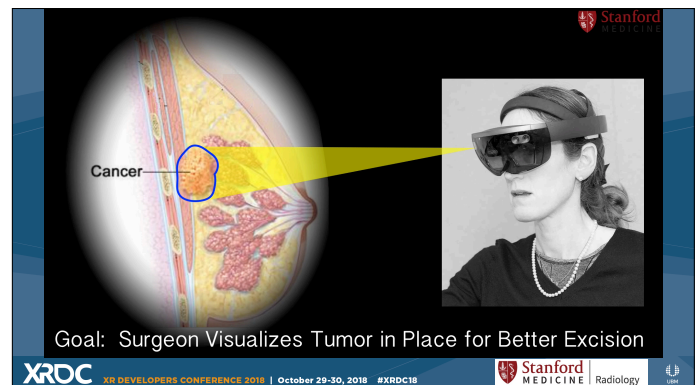
- 300,000 New Breast Cancer Cases
- 170,000 Undergo **Lumpectomy**
- 41,000 **Incomplete Excision**
- 26,000 **Completion Mastectomy**, most for lesions smaller than 2cm



Goal: Surgeon Visualizes Tumor in Place for Better Excision

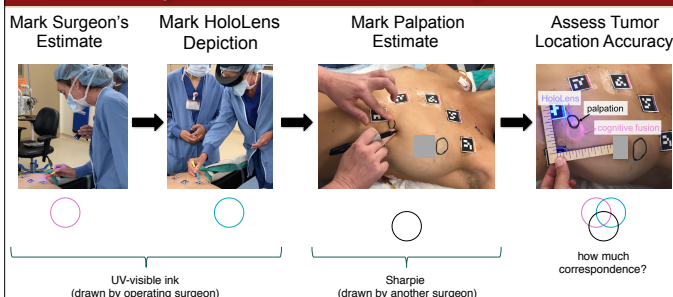
Concept and Prototype

- MRI of breast and lesion (supine)
- Segmentation (Skin, Lesion, Images)
- Patient-specific HoloLens App
- Alignment to Patient
- Initial test study



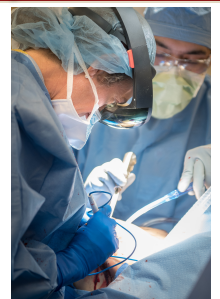
Goal: Surgeon Visualizes Tumor in Place for Better Excision

Pilot Study in Patients with Palpable Tumors

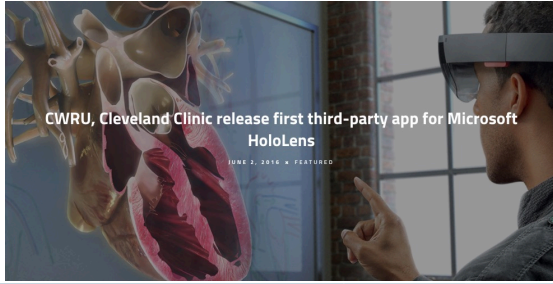


Summary: Breast Surgery Guidance

- Render size, shape, location of tumor
- Initial results:
 - Improves in all measures
 - Alignment still challenging
- Device somewhat compatible with OR



Mixed-Reality for Medical Education (CWRU)



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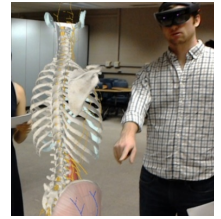
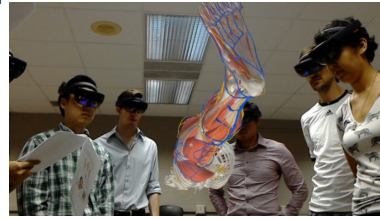
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Anatomy Teaching at CWRU with Holograms



- Multiple Users interacting with virtual objects
- Enables visualization of complex structures in a natural way

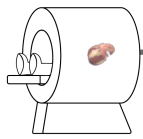


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Real-Time MRI + HoloLens Rendering



Real-time acquisition



Real-time reconstruction



Intuitive display system (HoloLens)

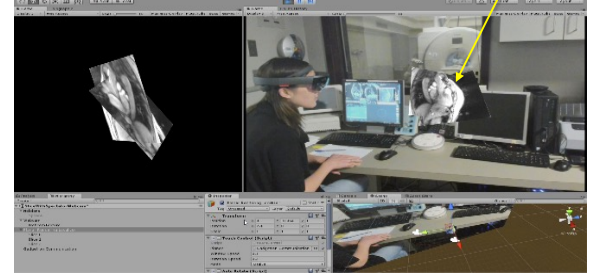


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MRI + HoloLens Setup

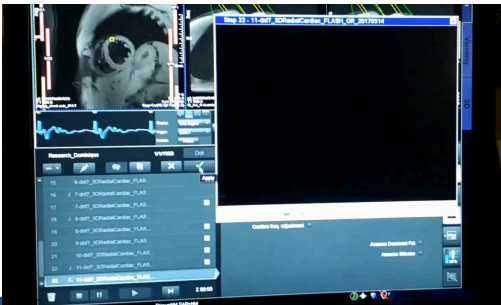


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Real-time, Volumetric Cardiac MRI

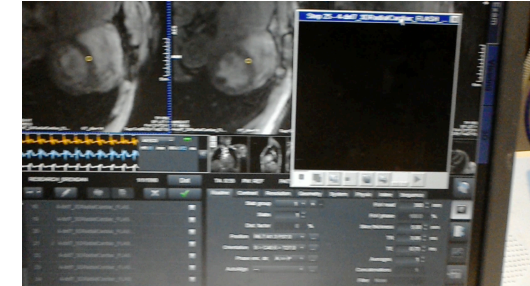


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Real-time, Volumetric Cardiac MRI



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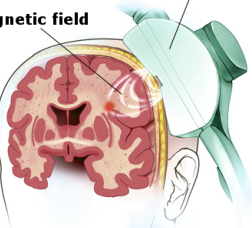


Transcranial Magnetic Stimulation (TMS)



Electromagnetic coil

Magnetic field



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Superimpose MRI on Subject

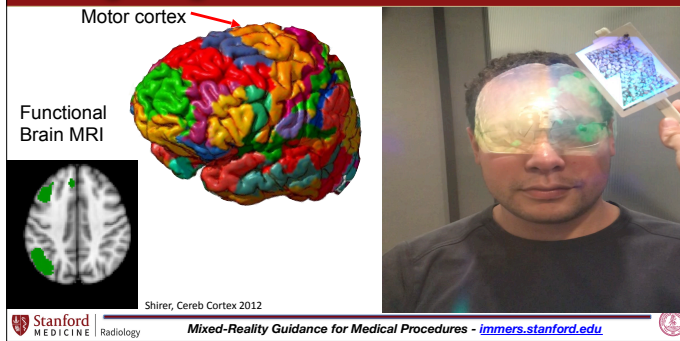


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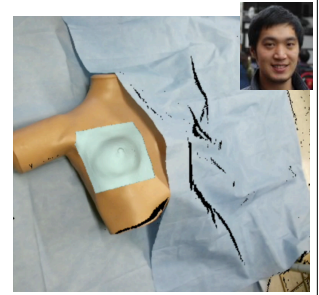


Targeting functional brain networks

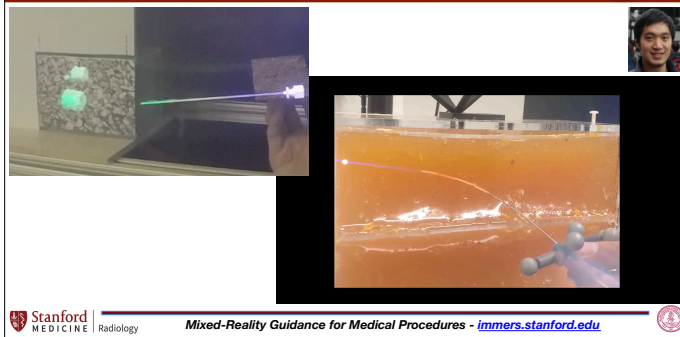


Alignment using Computer Vision

- RealSense camera
- Aligns image of skin (white) to mannequin

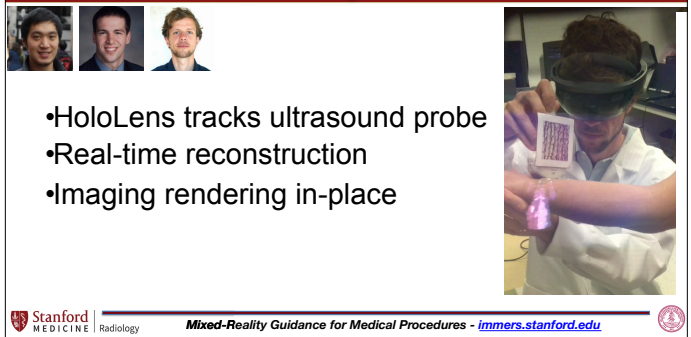


Demonstration: Needle Tracking

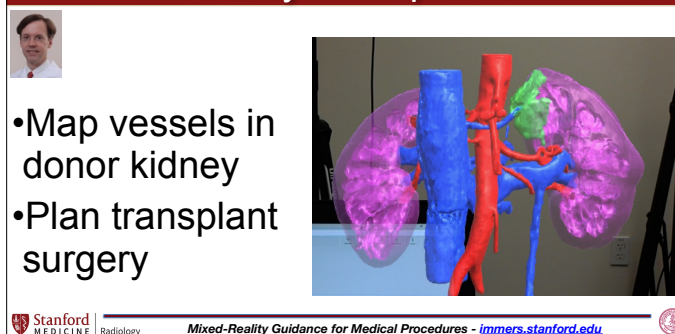


Mixed-Reality Ultrasound

- HoloLens tracks ultrasound probe
- Real-time reconstruction
- Imaging rendering in-place



Kidney Transplants

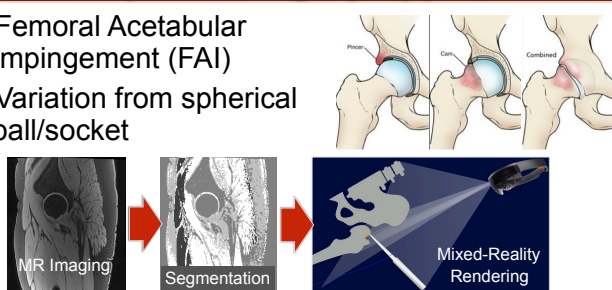


Lung Resection Surgery

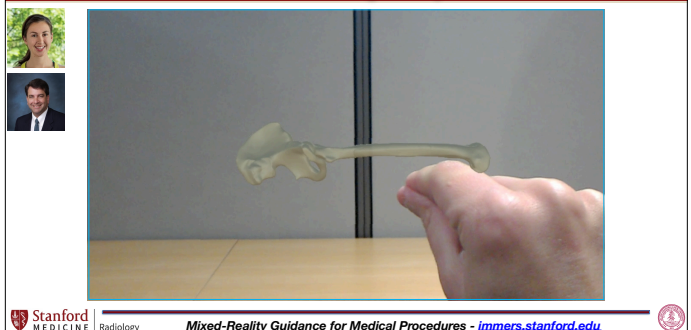


Orthopedic Surgery Applications

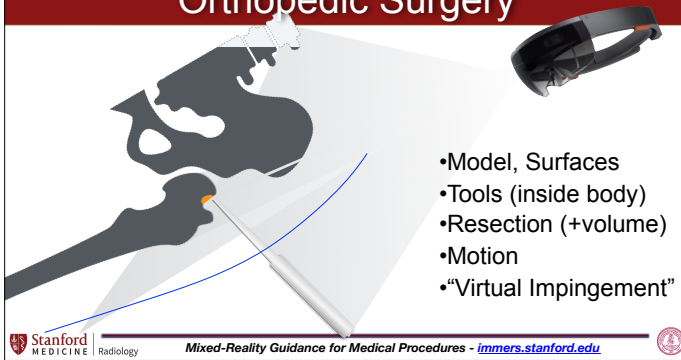
- Femoral Acetabular Impingement (FAI)
- Variation from spherical ball/socket



Mixed Reality Hip Joint



Orthopedic Surgery



Summary and Comments

- Mixed reality applications in medicine
 - Procedure guidance
 - Education
- Benefits vary with application
- Technology advances will enable more

Slide Acknowledgements

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