The Use of Augmented Reality in the Operating Room: a Review

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Scope of Survey

- Introduction to Augmented Reality
- Information Visualization in AR
- AR in Medicine
- Minimally-Invasive Surgery
- Medical Volume Visualization

Previously Covered

- Intro to AR
- Why we need AR in the operating room
- Overview of AR display options
- Medical procedures that could benefit

Goal for Today

- Impossible to summarize entirety of survey
- Instead, present 3 of most significant results:
  - Virtual depth perception in AR
  - AR-guided needle insertion
  - Uncertainty in medical volume visualization
- Conclude presentation with final thoughts

Virtual Depth Perception in AR

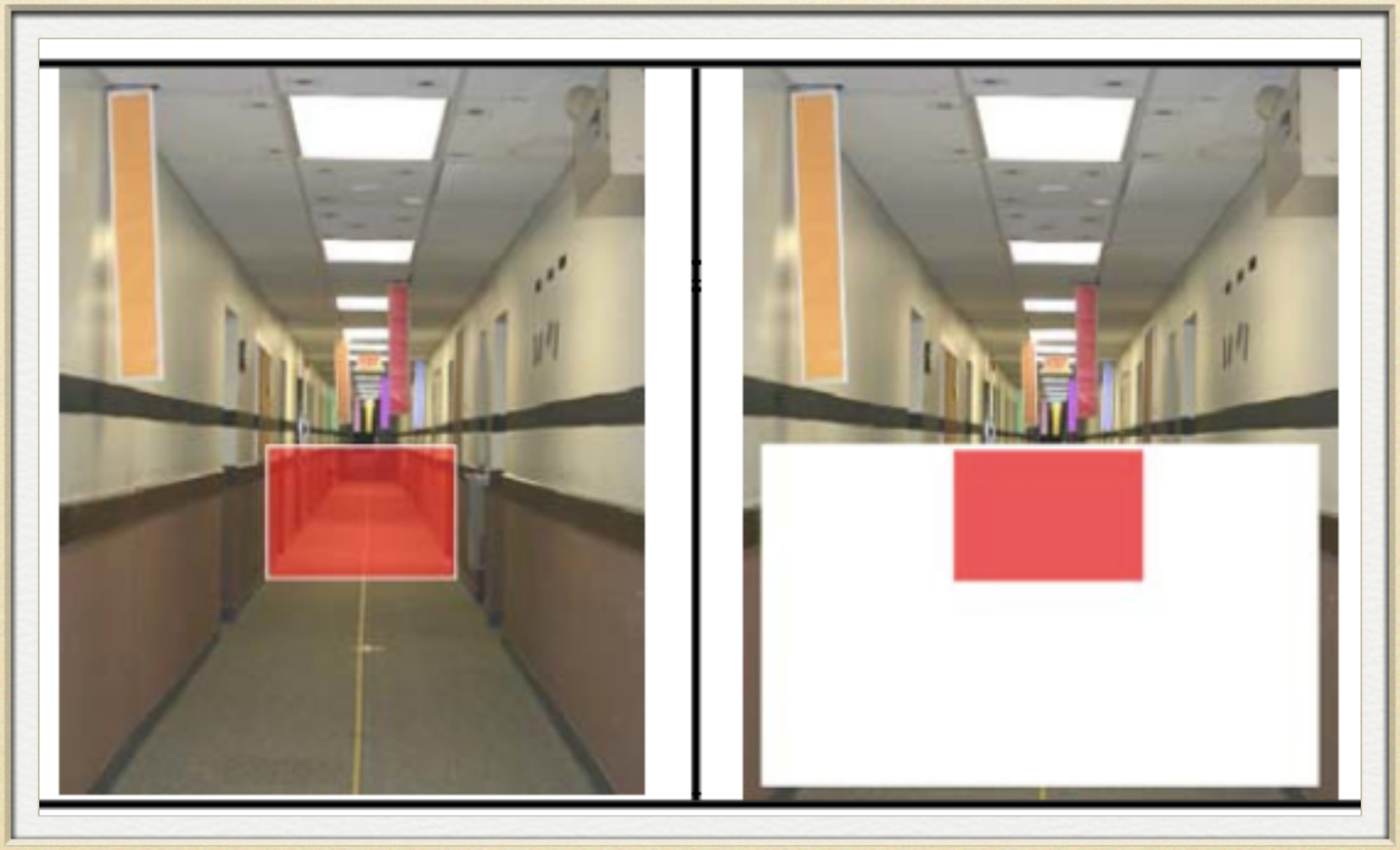
Virtual Depth Perception

- Essential for immersion
- Problems with optical displays:
  - display set at fixed depth in 3D world
  - depths underestimated with HMDs
  - “X-ray vision” uses purposely conflicting depth cues

Depth Cues

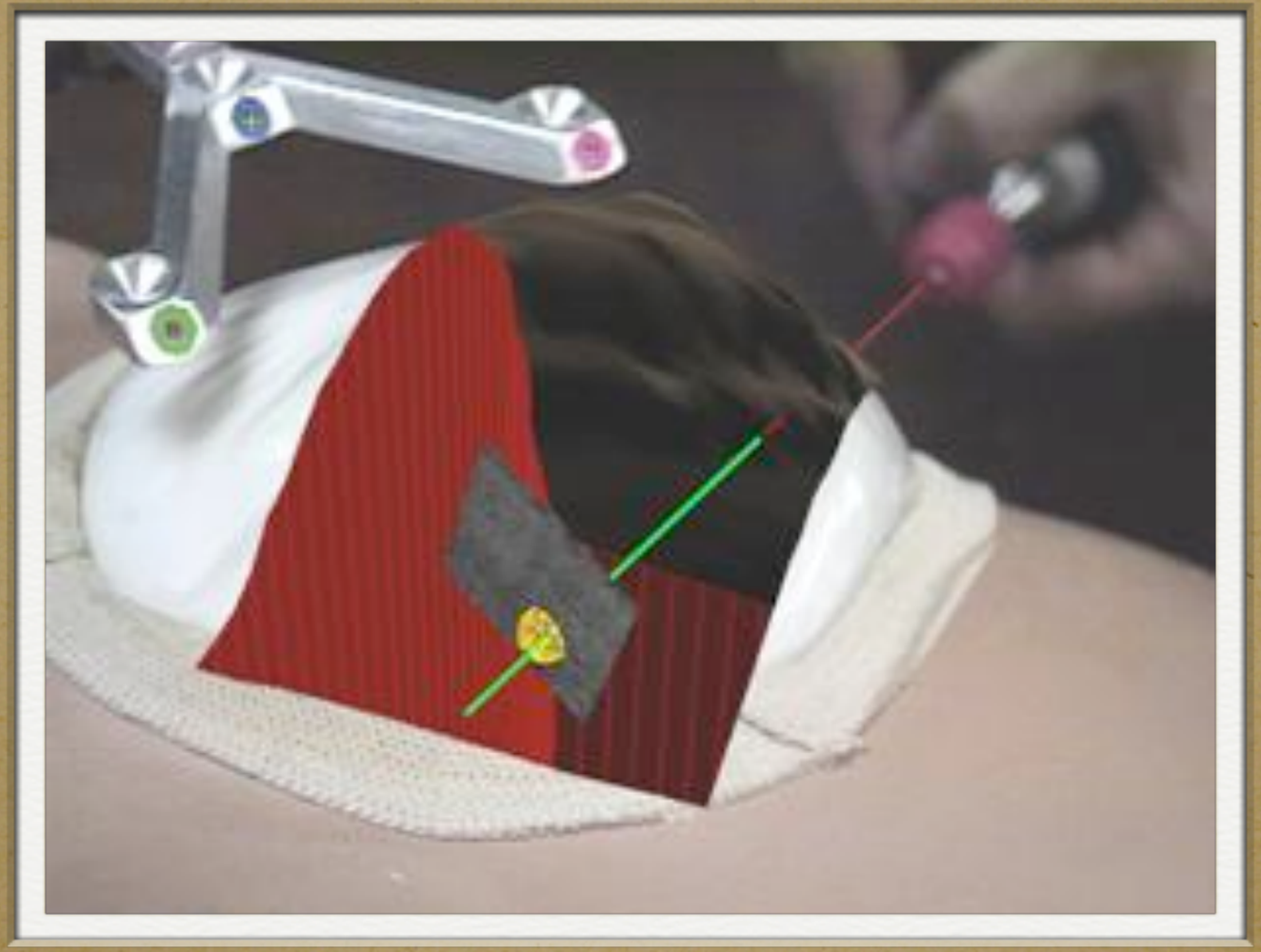
- binocular disparity
- binocular convergence
- accommodative focus
- atmospheric haze
- linear perspective and foreshortening
- motion parallax
- occlusion
- height in visual field
- shading
- texture gradient

Experiment: Perceptual Matching



Lesson

- Conflicting depth cues create problems for user depth judgement
- Standard optical see-through display not ideal for 3D x-ray vision
- Solution: add semi-transparent LCD panel or use video display



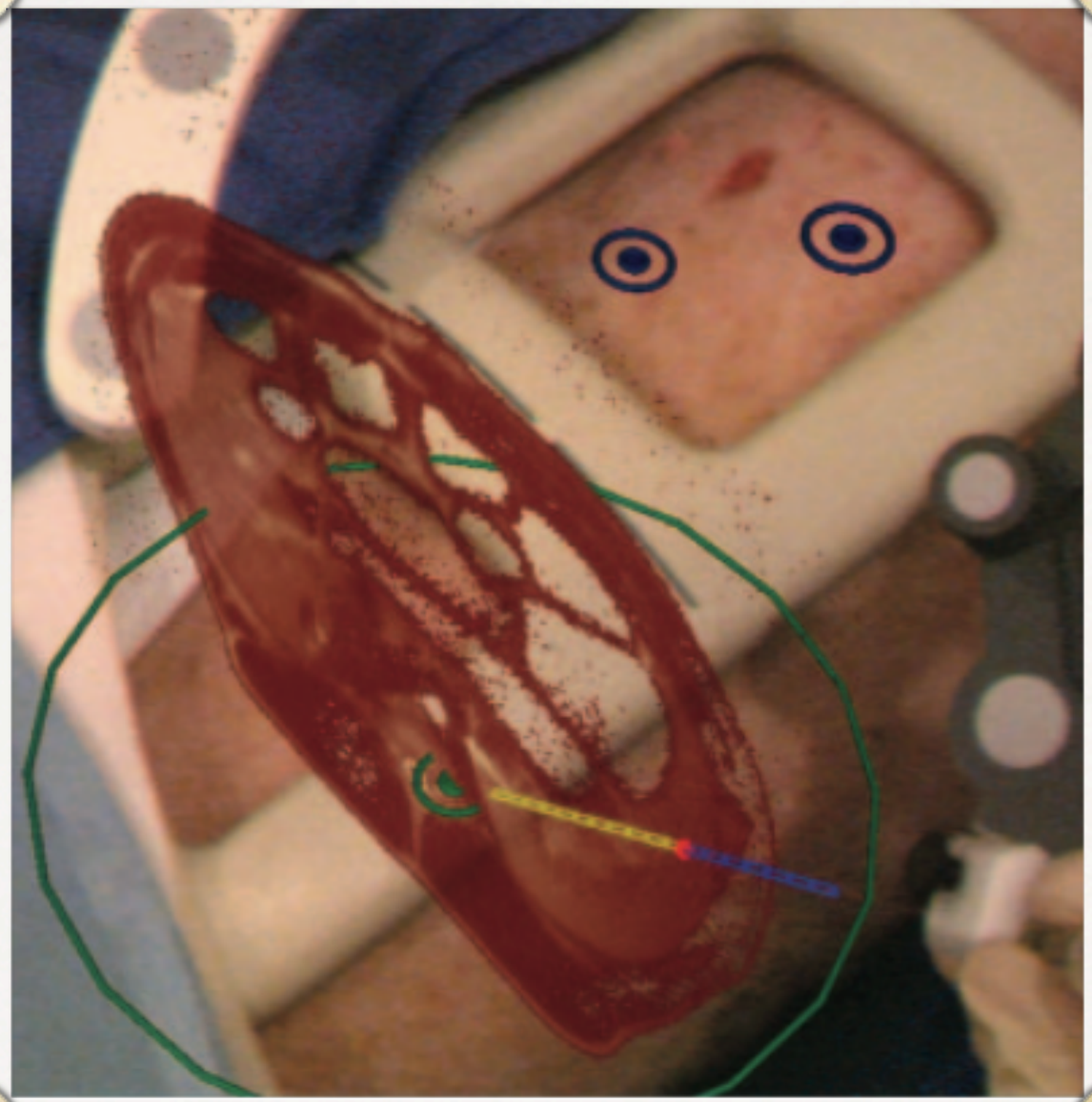
AR-guided Needle Insertion

Needle Insertion

- Accuracy important for biopsies and ablation
- Want to avoid sensitive structures, e.g. nerves
- MRI guidance
  - most machines too bulky for patient access
- CT guidance
  - prolonged radiation exposure

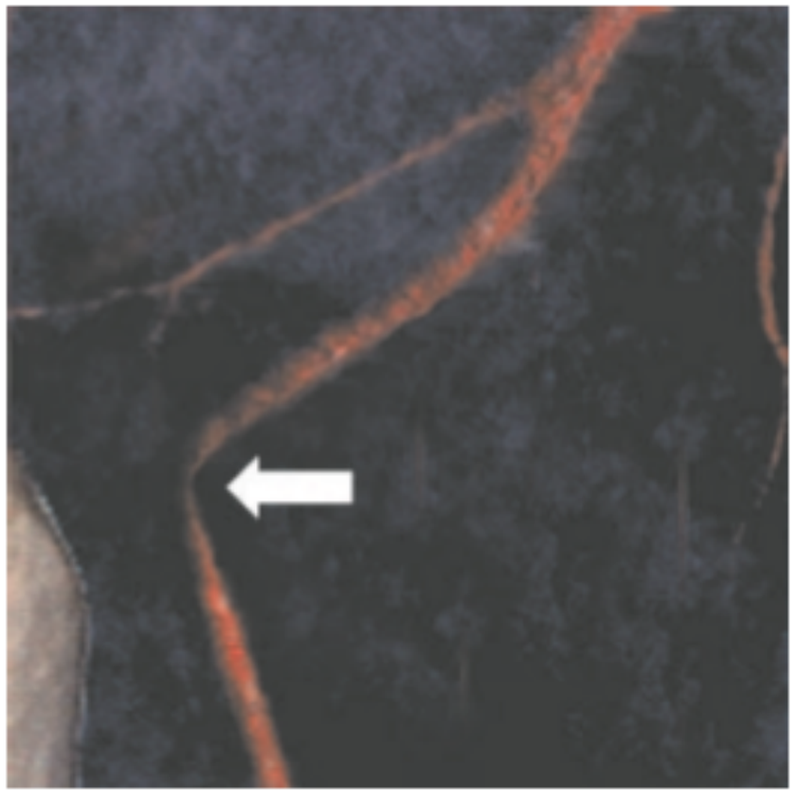
AR-enhanced Needle and Targets

- MRI or CT data is overlaid using HMD
- 7-cm virtual cylinder extends from needle tip
- Target areas are virtually highlighted



Needle Insertion: Summary

- AR technique is ready for implementation
- Limitations:
  - complexity of apparatus
  - requires immobilization of patient or motion correction
- Likely reserved for special cases in CT
  - CT-guidance already common



Uncertainty in Medical Volume Vis.

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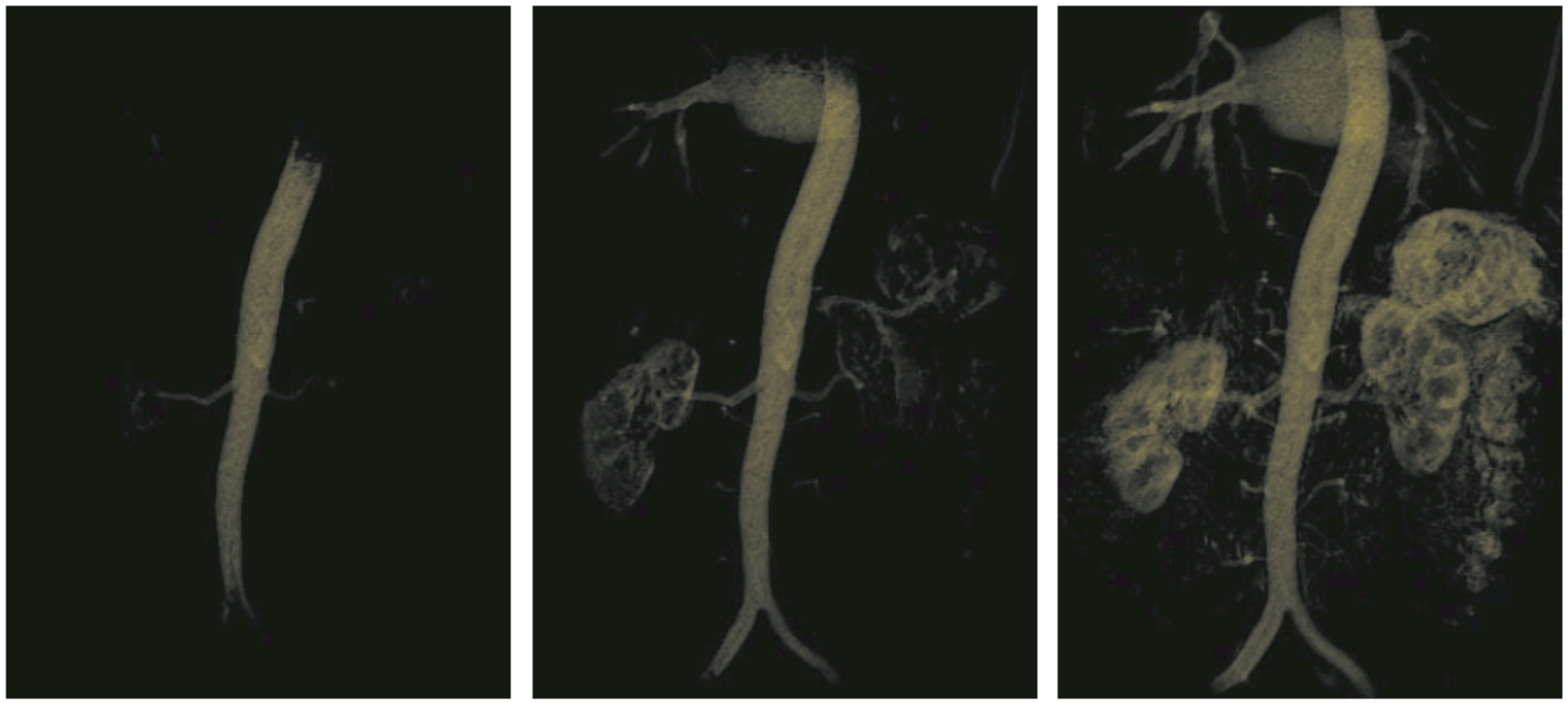
- Disregarding this can be life-threatening
  - e.g. could misjudge aortic width and insert stent of wrong size

- Radiologists manually adjust parameters to sample range of feasible values
  - time-consuming
  - not guaranteed to be comprehensive

Probabilistic Animation

- Perform fuzzy classification of tissues
- Fraction of frames a sample appears as type X represents probability that X is correct
- More effective than traditional static rendering
- Sensitivity lens used to localize animation

Probabilistic Animation: Example



Conclusions

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- Many applications of AR to medicine
- Different tools suited for different procedures
- Many techniques still need refinement
- Physicians will determine what gets adopted

Thank You