



NA-MIC

National Alliance for Medical Image Computing

<http://na-mic.org>

Mechanically Assisted Trans-Rectal Prostate Biopsy

DBP2: Prostate Interventions, Queen's University and JHU

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Goal for roadmap project

- End-to-end application for MR-guided robotically-assisted trans-rectal prostate biopsy
- Add slicer features relevant to clinical interventional procedures
- Utilize slicer in our diagnostic and therapeutic research programs for prostate cancer



Prostate cancer statistics

- One of every 6 men in the U.S. will be diagnosed
- 230,000 new cases in 2007
- incidence will double by 2025
- ~1 million needle biopsies per year
- (Add 10% for Canada, and double for Europe)
- ***Ultrasound guided biopsy is cheap, but has poor sensitivity. Cancers as large as a sugar cube are routinely missed***



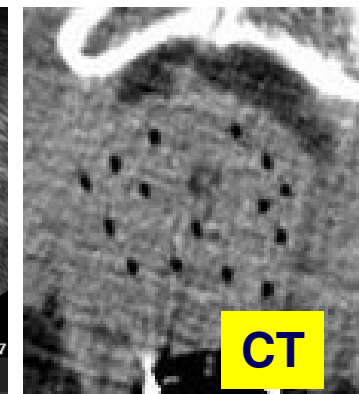
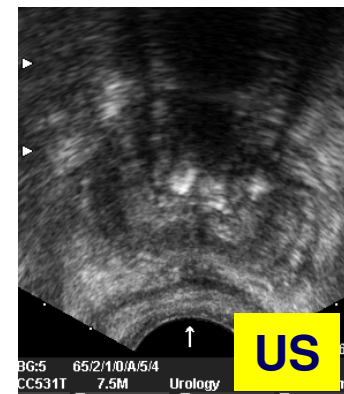
MRI for biopsy guidance

PROS

- Sensitivity in detecting soft tissue abnormalities
- Excellent visualization of prostate and normal tissues
- Morphological, functional and molecular imaging

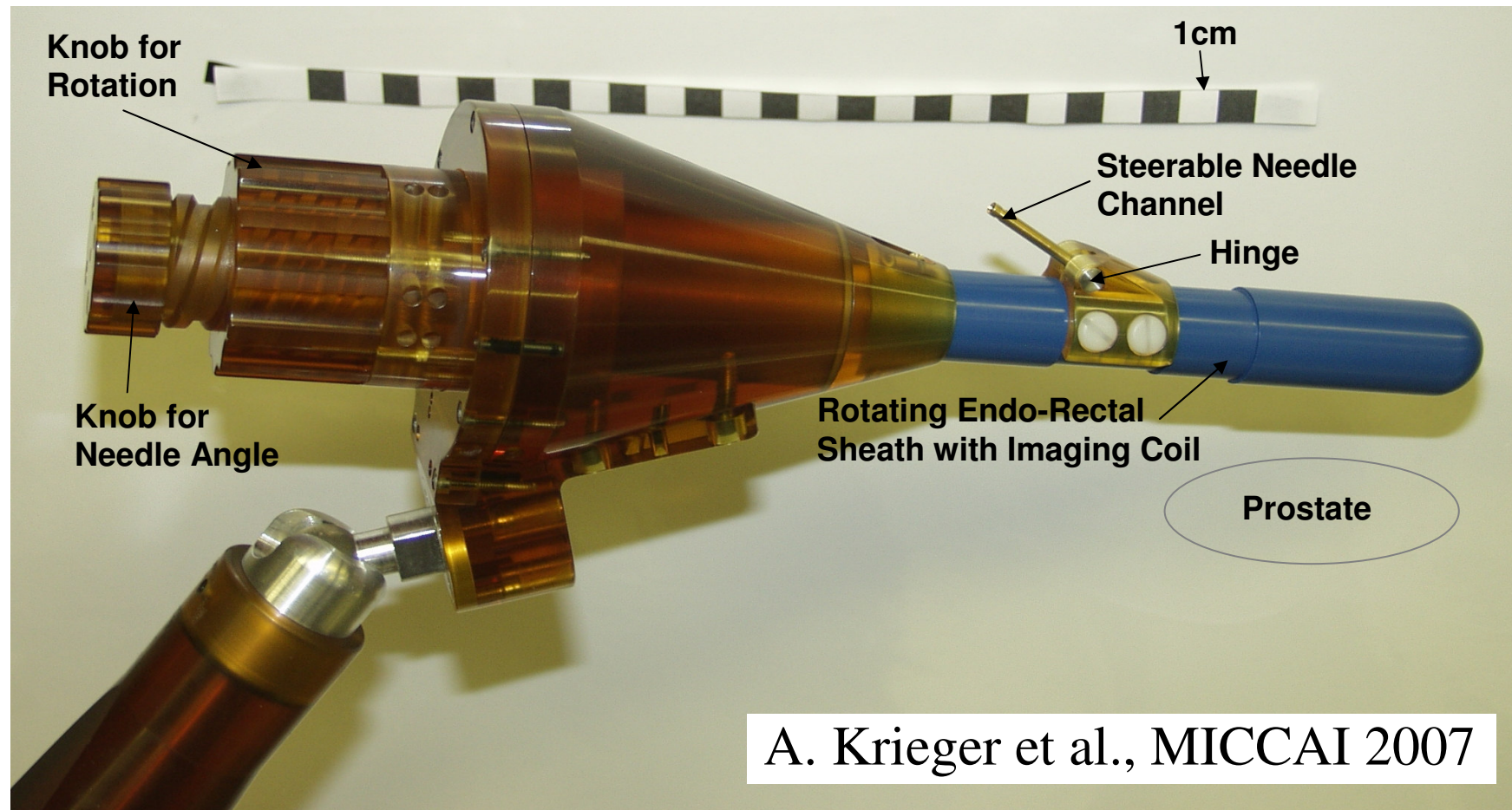
CONS

- Expensive, limited availability
- This is gradually changing as clinical efficacy is being proven





Trans-rectal, MR compatible





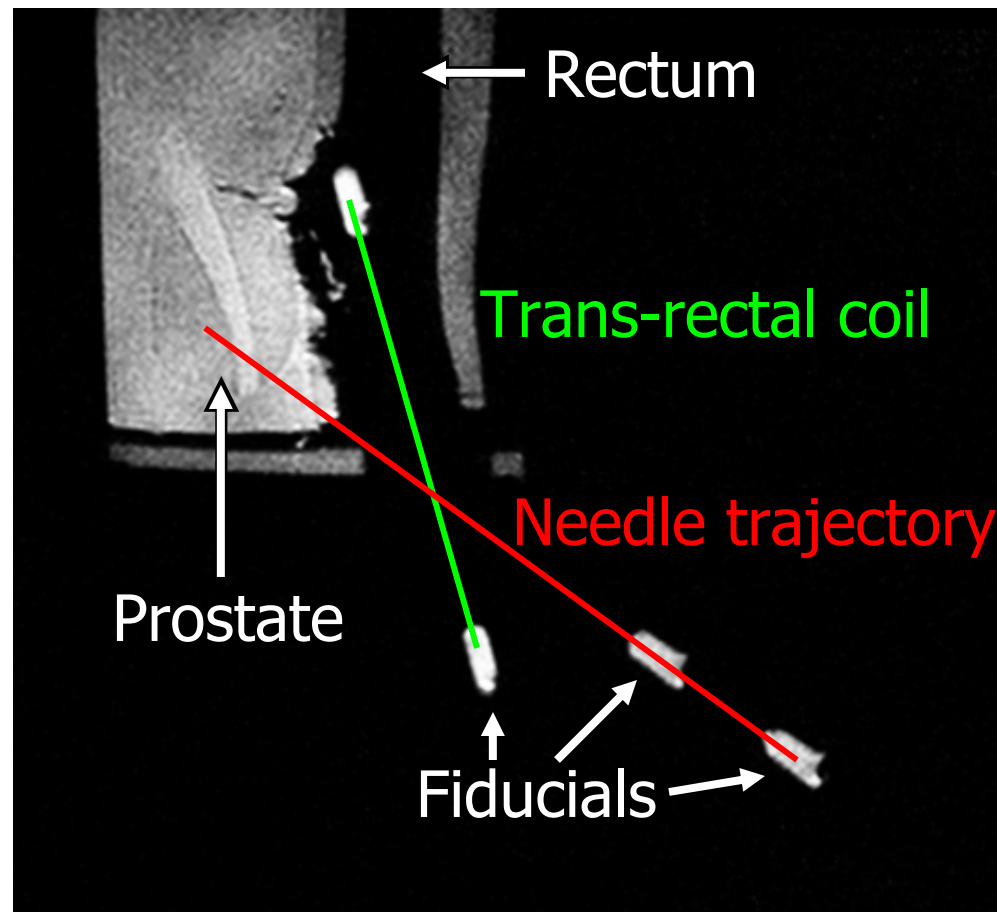
Implementation plan

- Interactive Slicer module
 - Workflow wizard à la EMSegment module
- Workflow:
 - Pre-op planning (future)
 - Robot pose calibration
 - Intra-op targeting
 - Post-biopsy verification



Calibration of Robot Pose

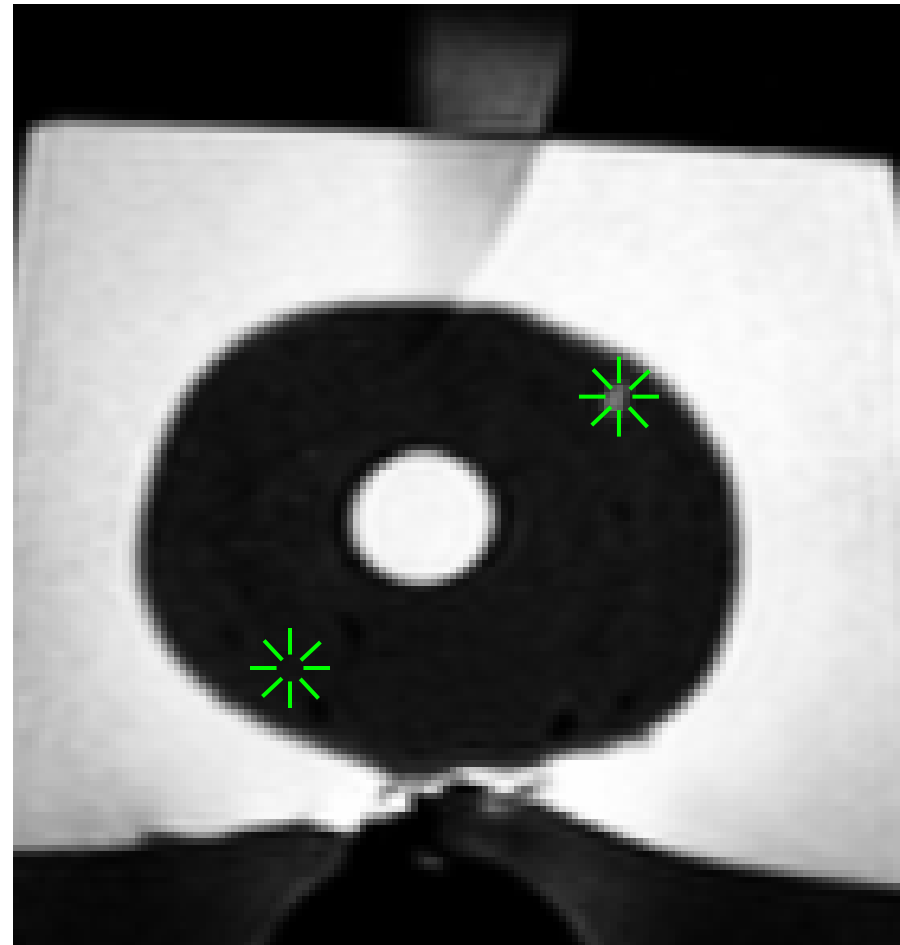
- Load thin-slab calibration image
- Semi-automatic identification of 4 robot fiducials
- Compute robot pose in scanner coords





Targeting biopsy sites

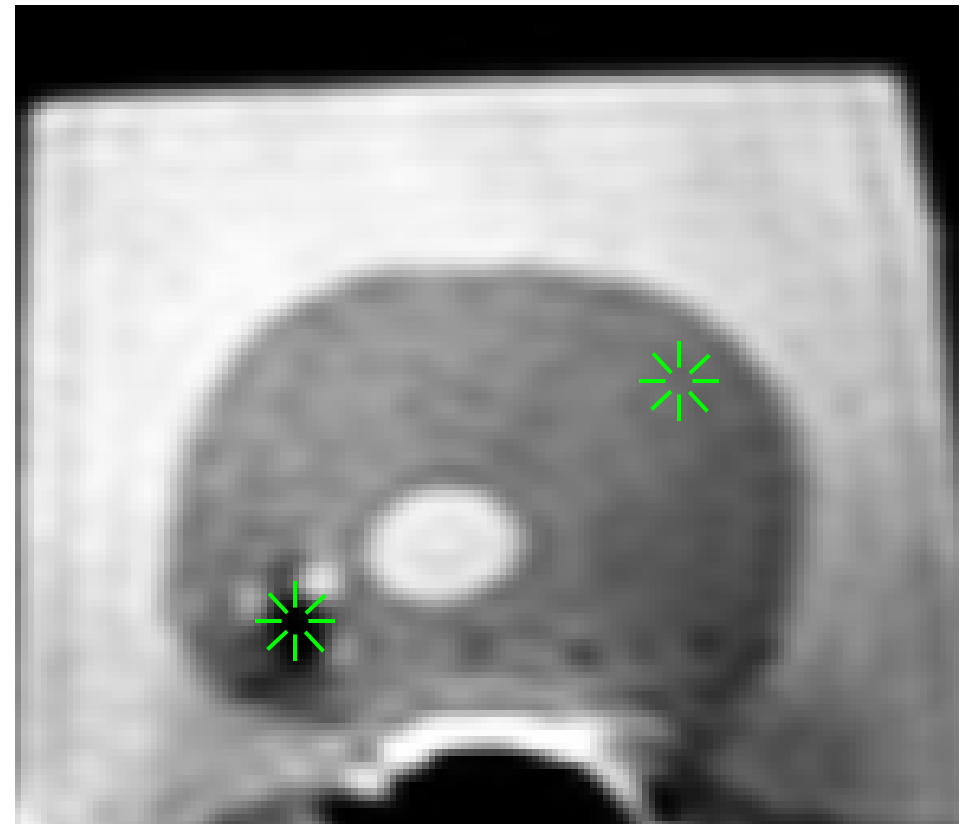
- Load targeting image
- Identify targets with Slicer fids
- Compute robot rotation, needle trajectory, needle depth
- Physician adjusts robot manually and takes biopsy





Verification after biopsy

- Scan after each biopsy (slice or thin slab)
- Compare needle void with planned target





Registration needs

- MR to MR registration
 - Currently, targets are manually placed on intra-op scan based on the pre-op plan
 - Better: pre-op to intra-op registration
 - Must be deformable registration
 - Prone vs. supine, robot in rectum
- MR to US highly desired for future
 - Compare MR to current TRUS procedures



Robot communication needs

- This is a “manual” robot
 - Positioned by hand, no motors
 - Robot joints have encoders, readouts must be displayed to the operator
 - Slicer IGT demon can be used
- Motorized version is forthcoming!



Display needs

- Dual-display required
 - #1: display by scanner console
 - #2: in-room for interventionalist
- In-room display properties:
 - Full-screen of one Slicer view
 - No interaction, just display





Data-handling needs

- Read DICOM oblique orientations
 - Needed for intervention in general
 - Use Slicer's IJK to RAS
- RAS to LPS conversion
 - Planning, targeting is always LPS
 - Scanner consoles are LPS



“Frame of Reference”

- Each procedure can involve several “frames of reference” (FORs)
 - i.e. motion occurs: calibration repeated
 - Need FOR identifier tags for data sets and fiducial lists
 - Data sets with different FORs must not be allowed to be overlaid or compared: very real risk to the patient



Feature Summary

- From NA-MIC
 - Workflow GUI infrastructure
 - Oriented images set from DICOM header
 - Registration
- From Queens/JHU
 - End-to-end application
 - Secondary full-screen display
 - Prostate-specific registration
- Shared
 - Multiple Frame-of-Reference in Slicer