Development of an open-source system for prostate biopsy training in Senegal

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Introduction

- Prostate cancer is the second most common type of cancer diagnosed in men
- In sub-Saharan Africa, the high number of cases has led to an increase in referrals to trans-rectal ultrasound (TRUS) guided prostate biopsy[1]
- This procedure requires training and proficiency in locating and targeting the four prostate zones using TRUS[2]
- We have partnered with an international aid program, **"Train the Trainers"**, to develop a feasible prostate biopsy training system for identification of the prostate zones, to be deployed in Senegal[3]
- We present the design and work in progress on the implementation of an open-source prostate biopsy training tool, consisting of a physical system and a training interface, highlighting the generation and evaluation of the critical training component of zonal anatomy overlay on TRUS

Methods

Dataset Generation

- We used corresponding TRUS and MRI volumes from 10 patients, and the prostate zonal segmentations performed on the MRI data[4,5]
- We overlaid the zonal segmentations onto the TRUS volumes using deformable fiducial registration (Figure 1) and used these as the simulated cases for TRUS imaging and zonal anatomy identification

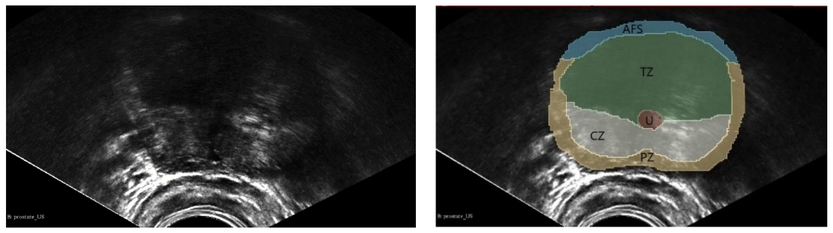

Figure 1: Prostate TRUS image *(left)* with labelled zonal anatomy registered and overlaid *(right)*.

Training Module Implementation

- We implemented a Python scripted module in 3D Slicer [6]
- The simulation scene includes a 3D view of the selected TRUS volume, a transducer, and the 2D sagittal view of the corresponding slice to the location of the transducer (Figure 2)

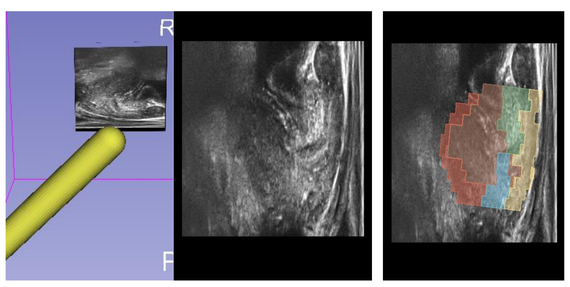

Figure 2: Screen shot of the training module. 3D view of the prostate volume with movable TRUS probe and corresponding 2D sagittal US slice *(left)*. Corresponding 2D slice with zonal overlay *(right)*.

Proposed Physical System:

- Mock TRUS probe
- ArUco Markers
- Mock rectum
- Laptop and Webcam

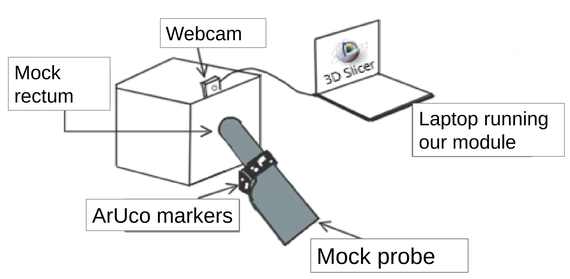

Figure 3: TRUS biopsy simulator design.

Experiments:

1. Load images of a patient to the scene
2. Scan using UI buttons or arrow keys
3. Toggle zonal overlay visibility
4. Identify zones by placing fiducials in correct regions

Methods Continued

Evaluation of zonal anatomy overlay

- Seven urologists responded to a two-part survey to evaluate our overlay for suitability in training zone identification:
  - Rated ten TRUS images overlaid with registered zonal anatomy on a 5-point scale based on how accurately it reflected their interpretation of the imaged prostate
  - Labelled a specified TRUS region as one of the four prostate zones (Figure 4). We compared their labels to our own overlay.

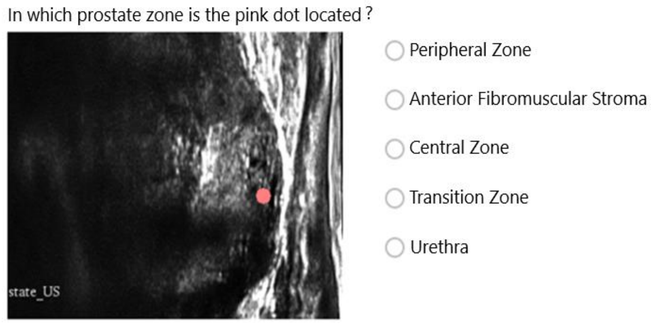

Figure 4: Example from the zone labelling section of the questionnaire.

Results

- On average, the experts rated the accuracy of the zonal overlay at 4 on a 5-point scale
- All experts labelled the transitional, anterior, and peripheral zones equivalently to our overlay. Five out of seven experts labelled the central zone equivalently to our overlay

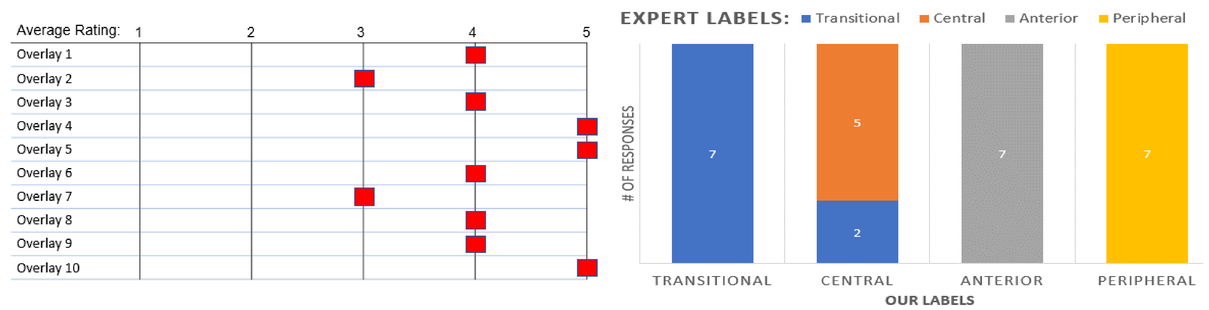

Figure 5: Results from the zonal overlay rating portion *(left)* and the labelling portion *(right)* of the survey.

Conclusion

- We designed the prototype of a TRUS biopsy imaging simulator in open-source software
- We developed and implemented a method to generate zonal overlays on TRUS, as one of the main features of the prostate biopsy training system
- The realism of the zonal overlay was deemed satisfactory in a survey by seven urologists

Acknowledgements

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