

Prostate Segmentation From 3DUS Using Regional Texture Classification and Shape Differences

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Background: Accurate diagnosis of prostate cancer relies on an accurate biopsy procedure. A biopsy must be performed on the center of a suspected malignant region in order to reliably diagnose the patient's condition. Tissue taken from the edge of this region, or outside the region altogether, can result in a negative test or misdiagnosis. The difficulty is that regions of interest (ROI) are identified on MRI images of the prostate, while image-guided biopsy is done using ultrasound. The great differences in appearance between these two modalities as well as shape deformations caused by the transrectal ultrasound transducer makes identifying these ROIs in the ultrasound image difficult.

Aims: To produce a method that can segment the prostate in 3D transrectal ultrasound and transfer identified ROI information from MRI images into 3DUS.

Methods: We introduce a method to segment the prostate in ultrasound using 1) a statistical model of prostate shape deformation caused by the transrectal ultrasound transducer and 2) regional ultrasound texture classifiers. Over a set of training data consisting of pairs of segmented MRI/3DTRUS images for each patient, we learn an average deformation and modes of variation of the prostate's shape between the MRI and TRUS images. We use skeletal representations (s-reps) to represent the prostate shapes [1], and build regions using corresponding locations of and near the object boundary across the training population. Using these, we learn regional classifiers of ultrasound tissue appearance (intensity and texture) using Distance-Weighted Discrimination[2] to yield probabilities of being inside the prostate.

For a target case, we apply the learned mean deformation to an s-rep fit to the patient's manually-segmented MRI image as an initialization. We deform the prostate shape along its modes of variation to match the image data. This image matching is performed by computing, for every voxel, the probability that it came from inside the prostate, based on its texture and location relative to the prostate boundary. Local s-rep boundary regions whose classification was shown reliable in training are adjusted in a refinement stage.

Results: We present results on a data set of 16 training and 13 target cases. We show the power of our appearance model in distinguishing between voxels from the interior and exterior of the prostate. Our segmentation results show good performance, with average MAD between our surfaces and ground-truth manual segmentations of 1.73mm and an average DSC of 0.892.

Conclusions: Regional classification via intensity and texture to yield probabilities together with a shape space on MRI-to-TRUS s-rep shape change results in attractive prostate segmentations.

Acknowledgements: We thank Derek Merck for his work in the early stages of the project and J. S. Marron for his useful advice on DWD and related statistical matters. Funded in part by NIH grant R21-CA129775.

References:

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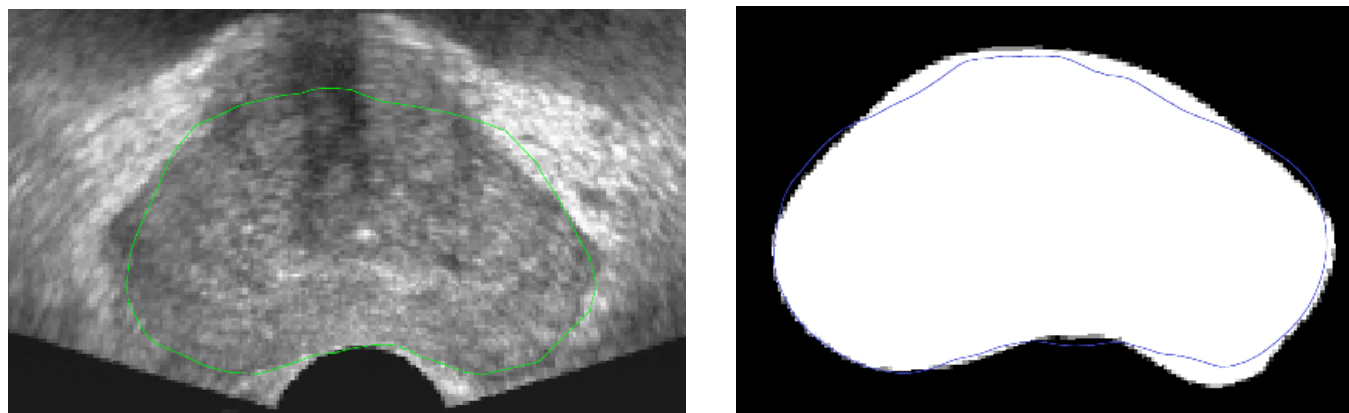


Figure: Selected segmentation results, shown left against a slice of the TRUS image and right against the manual segmentation.