AUTOMATIC PROSTATE SEGMENTATION FROM TRANSRECTAL ULTRASOUND IMAGES USING CONVOLUTIONAL NEURAL NETWORKS

Ghavami N., Hu Y., Bonmati, E., Rodell, R., Gibson, E., Moore, C., Barratt, D.

cmic Centre for Medical Image Computing
EPSRC Pioneering research and skills
UCL EPSRC CDT in Medical Imaging
UCL

Abstract- Identification of clinically important targets, is challenging on TRUS images, yet, much better defined on MRI. An important step for many MRI-TRUS registration involves automatic segmentation of the prostate on both modalities. In this work, a CNN is proposed for segmenting the prostate in 2D TRUS slices. achieving mean 2D DSC and absolute boundary distance error of 0.89±0.12 and 1.80±2.05mm respectively, suggesting a promising approach to aiding TRUS-guided prostate cancer procedures.

Background

- Prostate cancer is the most commonly diagnosed cancer in men in the UK, with more than 11,000 deaths per year.
- PSA testing leads to over-diagnosis and over-treatment of patients with low-risk prostate cancer [1].
- TRUS guided biopsies allow for more accurate patient stratification- however, clinically important tumours are frequently missed.

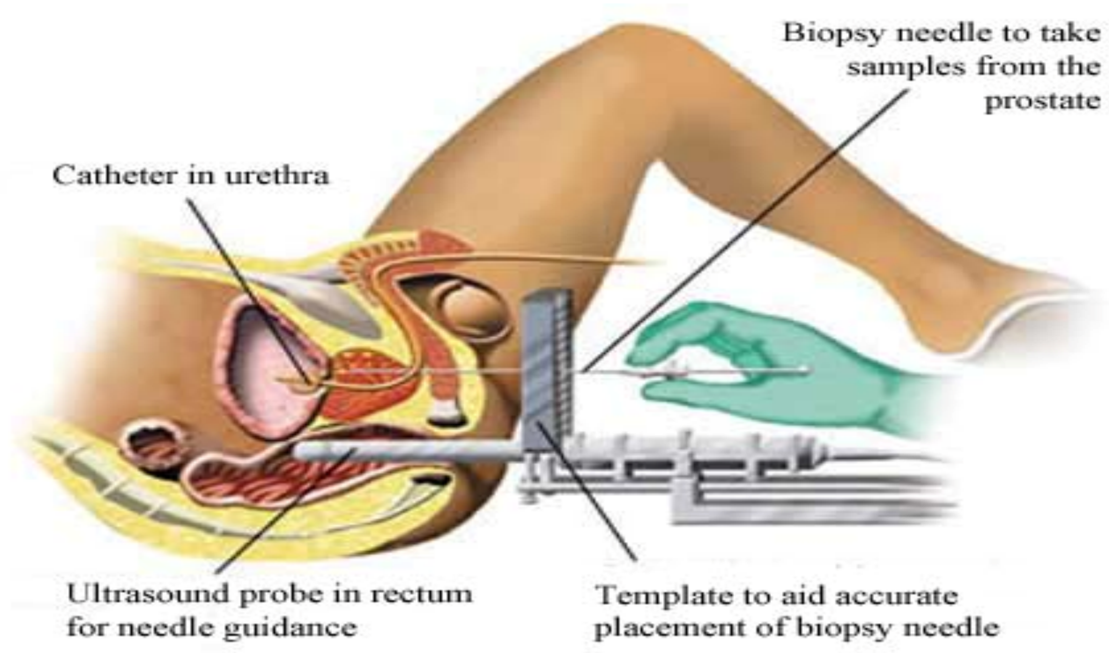

Fig.1 – Diagram of TRUS guided biopsy.

- MRI allows better visualisation, and fusion of the two modalities allows a cheaper, better localisation method [2].
- Automatic segmentation allows more accurate results with reduced time and variability compared to manual segmentations.

Aims

- Evaluate the accuracy of a convolutional neural network (CNN) method for automatic prostate segmentation
- Incorporation of an additive up-sampling.
- Investigate effect of integration of adjacent slices into the network

Methods

- Data was acquired from the SmartTarget Biopsy Trial [3], a total of 4034 slices were used.
- Automatic segmentations was carried out using CNN based on an adapted UNet architecture (**Fig.2**).
- 10-fold patient level cross validation was carried out, within each fold segmentation metrics such as the Dice similarity coefficient (DSC) and symmetric boundary distance were computed.

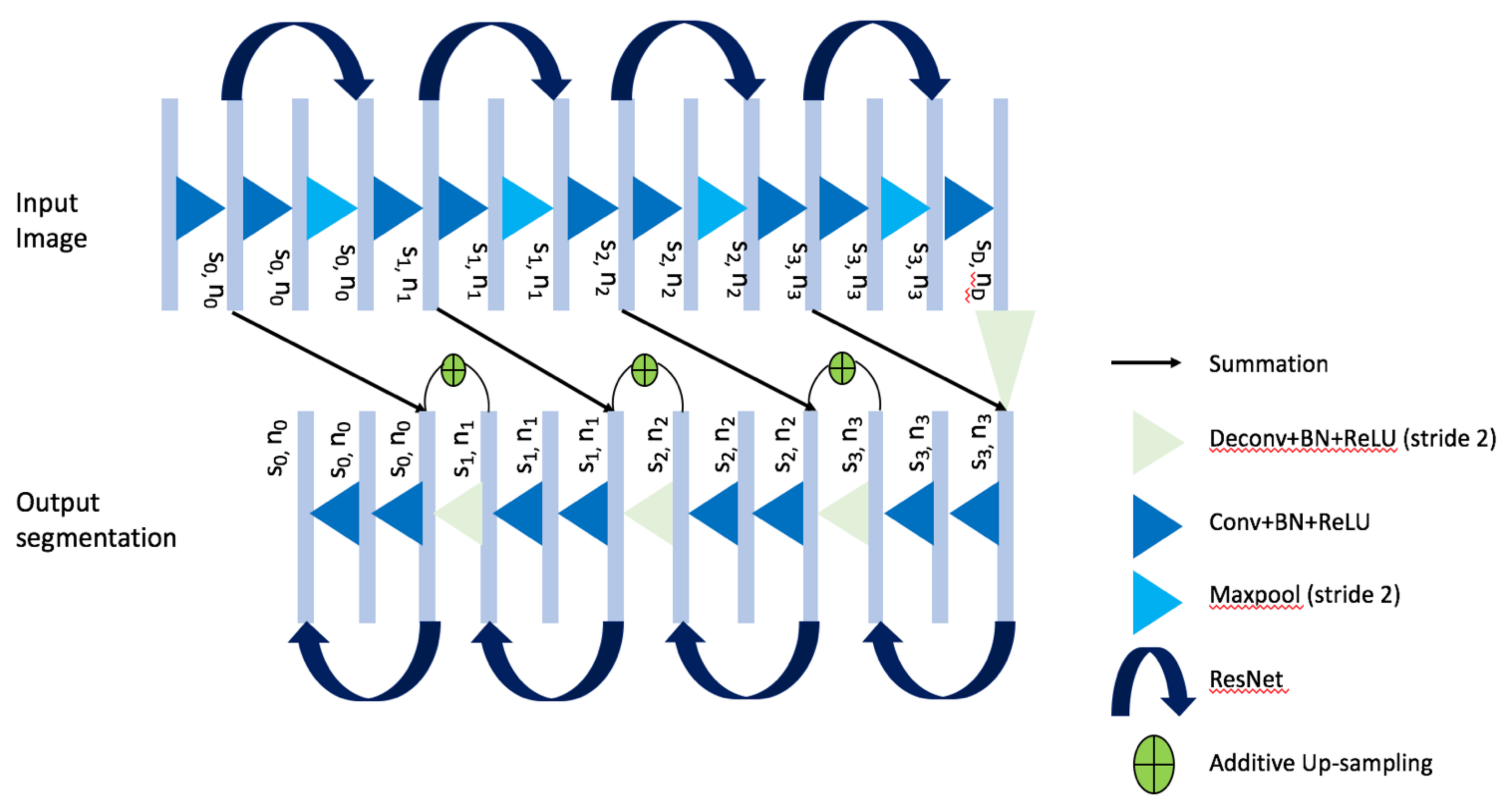

Fig.2 – Proposed network architecture.

Results

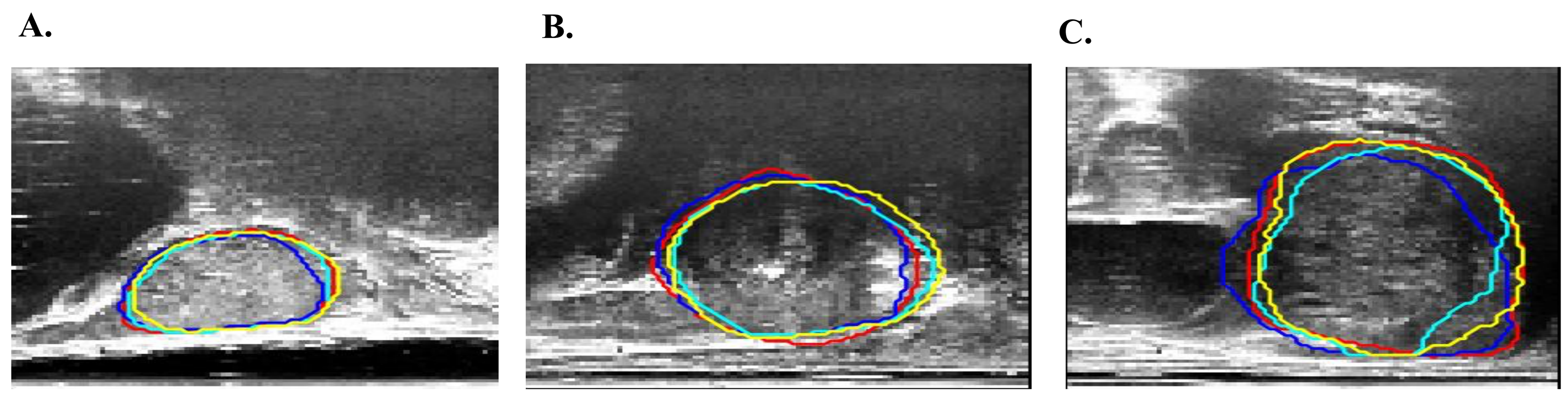

Fig.3 – Differences in the automatically segmented prostate when incorporating different number of adjacent slices for 3 arbitrarily chosen slices (**A-C**).

Number of Adjacent Slices on Each Side	2D DSC	3D DSC	Boundary Distance
None	0.88±0.13	0.88±0.06	1.80±1.68
1	0.89±0.12	0.89±0.05	1.80±2.05
2	0.89±0.12	0.88±0.04	1.77±1.46
3	0.89±0.12	0.88±0.05	1.75±1.77

Table.1 – Segmentation metrics obtained from the automatic segmentation results when using different number of adjacent slices.

- Inter-observer Comparison

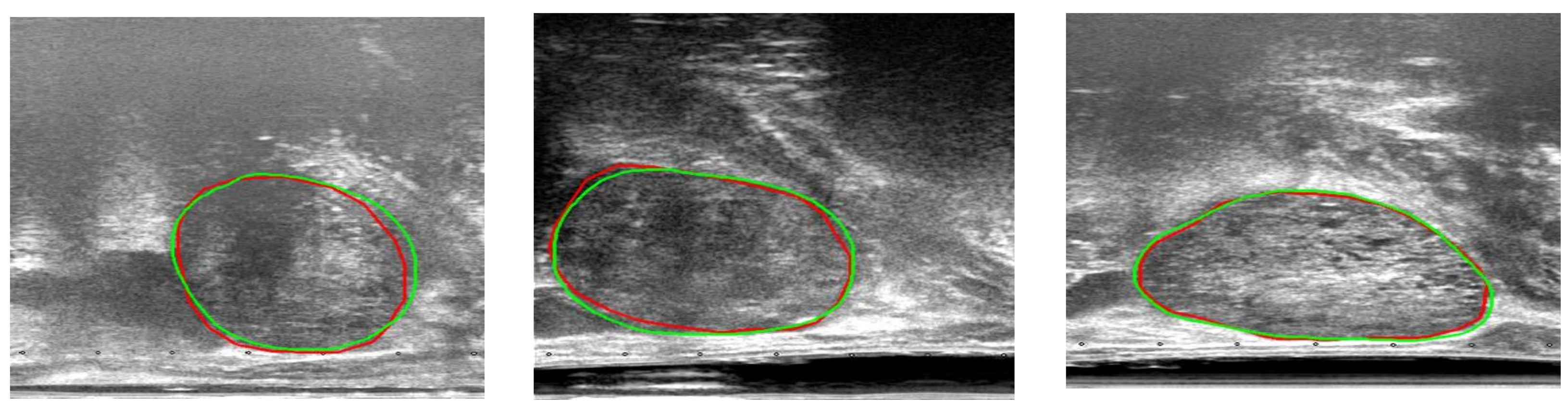

Fig.4 – Inter-observer segmentation comparisons for three arbitrarily shown slices.

Conclusion and Future Work

- Good agreement is shown between automatic and manual segmentations.
- DSC achieved close to inter-observer computed DSC (0.92±0.06)
- Obtain data from different centres.
- Use the segmentations within a MR-TRUS registration workflow- MR segmentations have already been carried out (**Fig.5**).

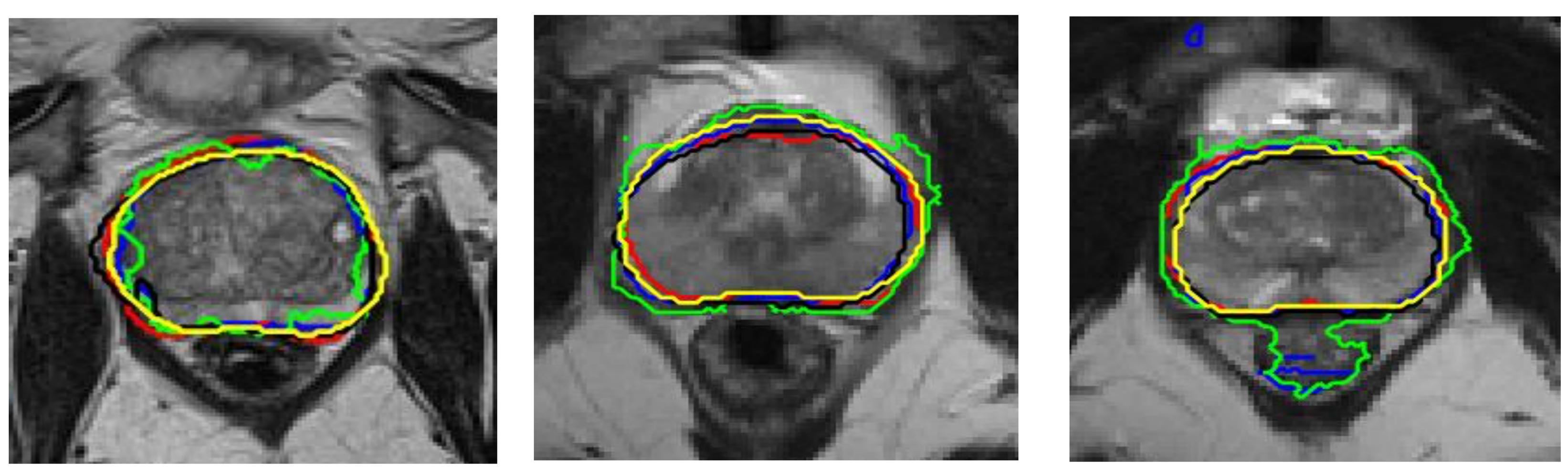

Fig.5 – Overlay images of the automatic segmentations from different CNNs on top of the original prostate image for three arbitrarily chosen slices.

References

[1]- Klotz, L., & Emberton, M. (2014). Management of low risk prostate cancer-active surveillance and focal therapy. *Nature Reviews Clinical Oncology* , pp. 324-334.
[2]- Sankineni, S., *et al*. (2015). Posterior subcapsular prostate cancer: identification with mpMRI and MRI/TRUS fusion-guided biopsy. *Abdominal Imaging*, 40(7), pp. 2557-2565.
[3]- Donaldson, I., et al. (2017). MP33-20 The SmartTarget Biopsy Trial: A Prospective Paired Blinded Trial with Randomization to Compare Visual-estimation and Image-fusion Targeted Prostate Biopsies. *The Journal of Urology.*197(4), p.425