Semi-automatic contouring for prostate cancer patients based on random forest classifier and active contour algorithm implemented in open source application called ITK-SNAP

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INTRODUCTION

- Crucial to the success of daily adaptation and inter-institutional and intradisciplinary research is reproducible and quick contouring to minimize user bias.
- Automation of contouring and dose in real time has been an ongoing effort by companies and academic institutions with little success on this front.

AIM

Study the feasibility of semi-automatic contouring based on Random forest based classifier and active snakes algorithm implemented in open source software application ITK-SNAP.

METHOD

Critical organs namely bladder, rectum and femoral heads were studied from 9 randomly selected prostate cases.

In ITK-SNAP, **random forest based classifier is trained based on manual definition of tissue of interest to generate foreground class contour for organ of interest and rest of the tissue as background class.**

Figure 1 : Six labels were used to define foreground and background class for bladder.

Figure 2 : Speed image after first epoch of Radom forest classifier is shown. As expected bladder is at foreground and rest of the surrounding tissue is background.

Figure 3: The second stage, where user initializes (seed point) active contour inside the ROI

Figure 4: Finally evolved contour filling the entire three-dimensional foreground labeled ROI for bladder contour.

Figure 1: Manual definition of tissue of interest to generate foreground class contour for organ of interest and rest of the surrounding tissue as background class

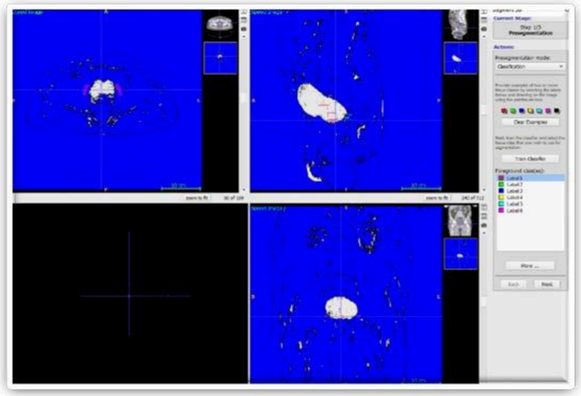

Figure 2: Speed image after first epoch of Radom forest classifier. Bladder is at foreground and rest of the surrounding tissue is background as expected

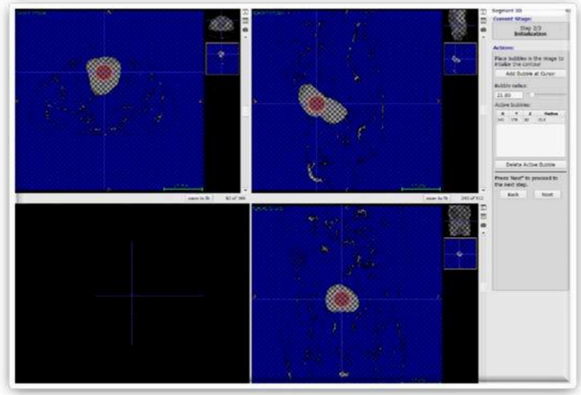

Figure 3: Seed point active contour inside the region of interest (ROI)

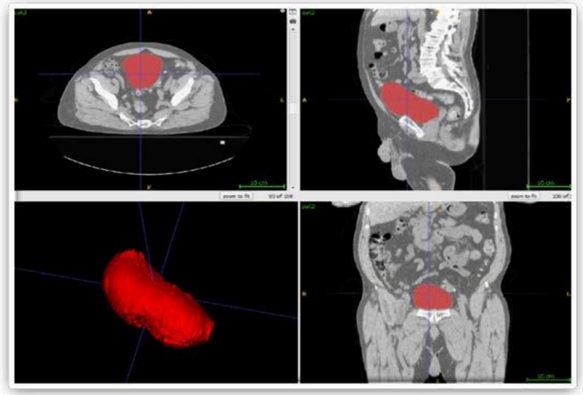

Figure 4: Contour evolved to filling up the entire three-dimensional (3D) ROI i.e., Bladder

RESULTS

- Semi-automatic generated bladder, rectum contours for nine randomly picked prostate cancer patients were very comparable to clinically drawn contours for radiotherapy planning.
- Average dice similarity coefficient for 80% of the contours generated were >0.93 with 20% of the cases needing minor editing to improve the dice coefficient.

CONCLUSIONS

- Study demonstrates that semi-automated 3D contouring is possible reliably enough to replace subjective and tedious manual contouring.
- Tools like ITK-SNAP are freely available to all and easy to learn
- Enables for more robust contouring for inter-institutional and inter-disciplinary studies
- enable radiotherapy clinics to implement daily adaptation of radiotherapy plan and near real time dose tracking.

REFERENCES

P. A. Yushkevich, Y. Gao and G. Gerig, "ITK-SNAP: An interactive tool for semi-automatic segmentation of multi-modality biomedical images," 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Orlando, FL, 2016, pp. 3342-3345, doi: 0.1109/EMBC.2016.7591443.

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