A Comparison of Interpolation Methods in Head and Neck Radiotherapy Contouring

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INTRODUCTION

Manual contouring of organs at risk (OAR) in radiotherapy (RT) planning is often time consuming and laborious. Interpolation methods are a useful generic tool, and can supplement manual approaches in a clinical setting. We compare two interpolation methods that do not incorporate prior knowledge of the target structure, and present example results for structures from the head and neck.

This work is an assessment of OAR contouring methods in RT. The intention is to investigate the dependence on the initial user input in such approaches, in order to determine potential advantages of each method in a clinical setting.

METHOD

We consider certain OAR in the head and neck as an example (cord, brainstem, parotid glands, submandibular glands, hyoid).

The proposed data-driven interpolation (DDI) algorithm is an extension of 3D minimal path approaches [1]. An approximated surface is then refined using a fast regularisation step, based on convex variational methods [2].

Our approach is summarised as follows:

- We assume knowledge of multiple axial contours, as well as two orthogonal contours (from the sagittal and coronal views).
- Contours are distributed evenly throughout the structure (although in practice they would be provided manually).
- We compare the proposed DDI algorithm to results obtained by linear interpolation (LI).
- Performance quantification in terms of accuracy is by the Dice Similarity Coefficient (DSC).
- Complete outlines for seven structures from five data sets are tested.

RESULTS

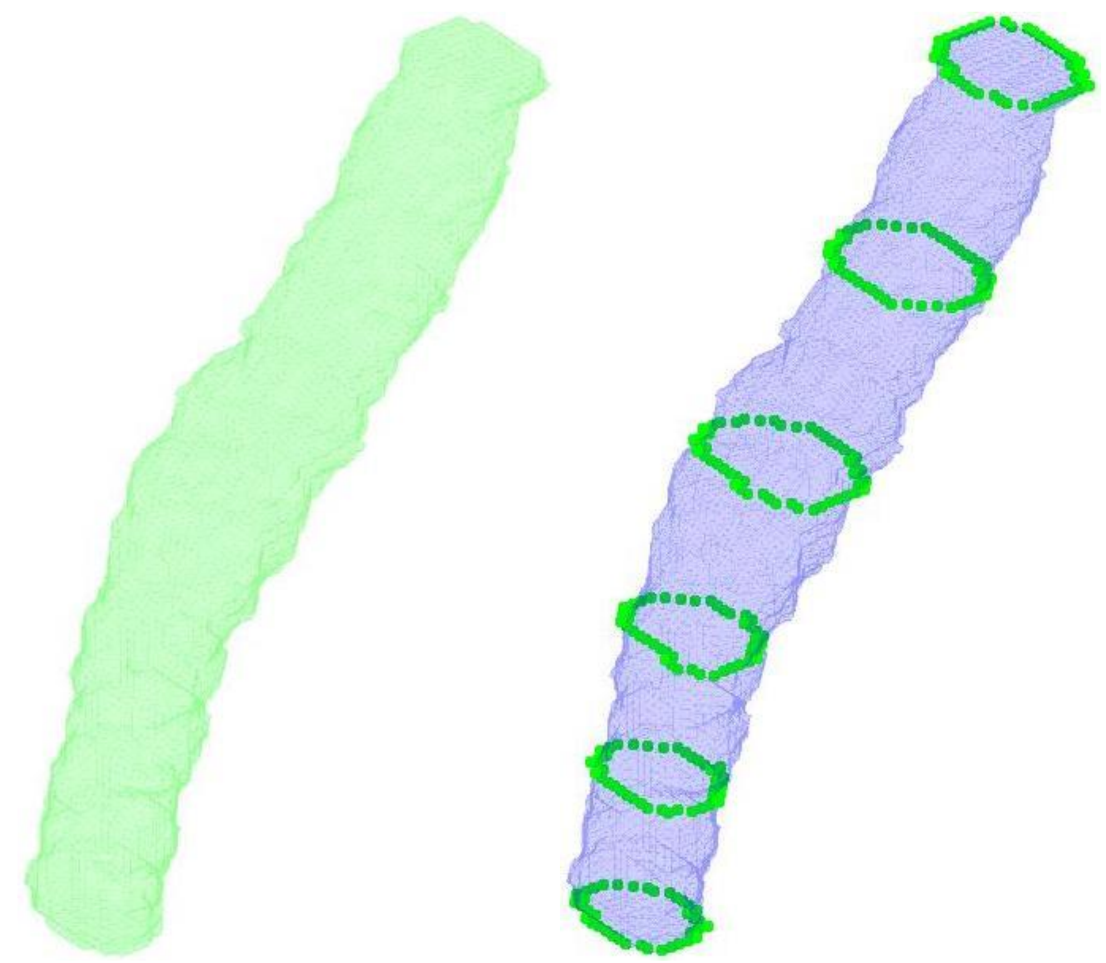


Figure. Above: the structure of the cord, with known axial contours given in green. Below (left/right): cross sections of an example result. Accurate contour (green), LI contour (red), and DDI contour (blue).

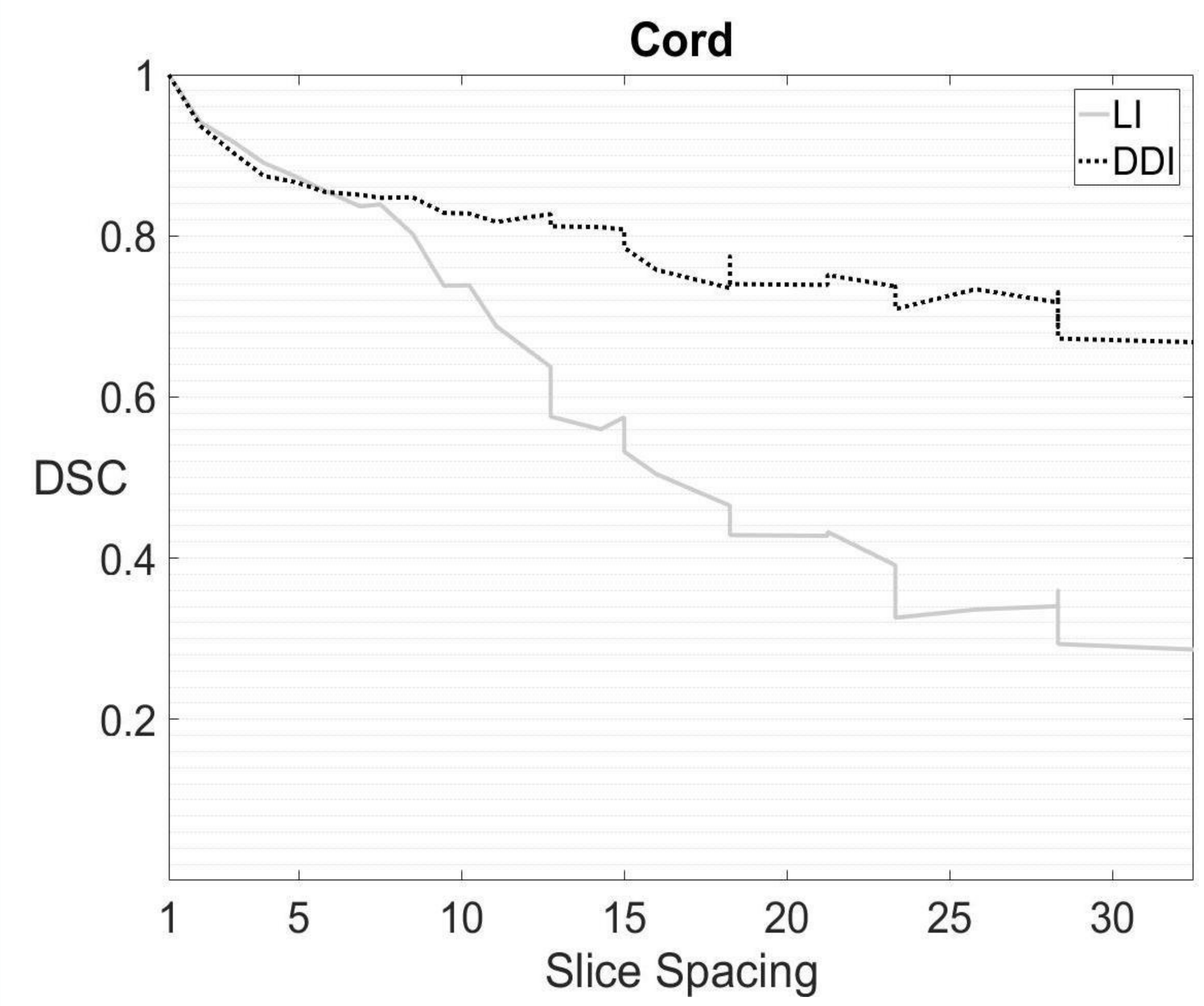
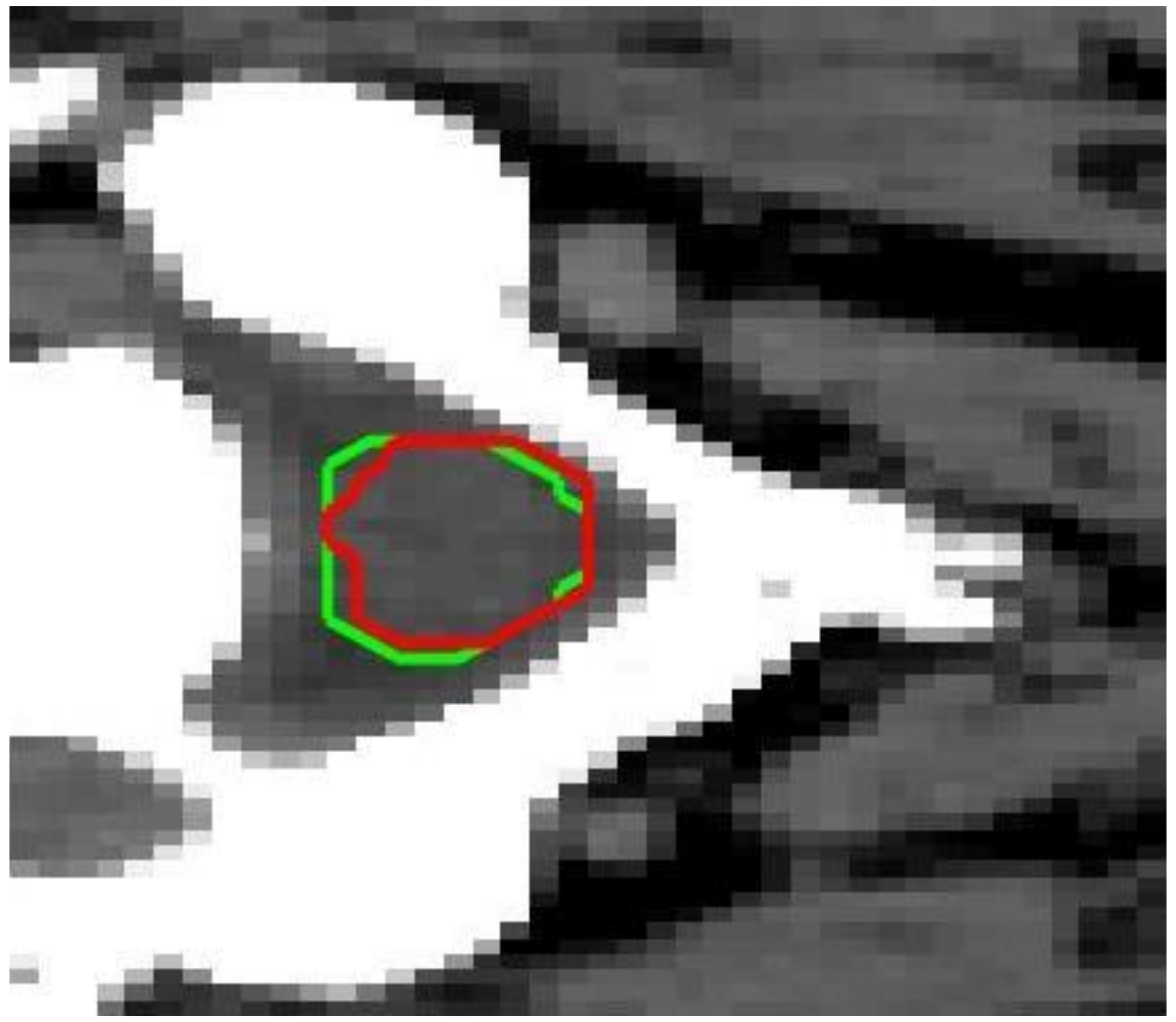
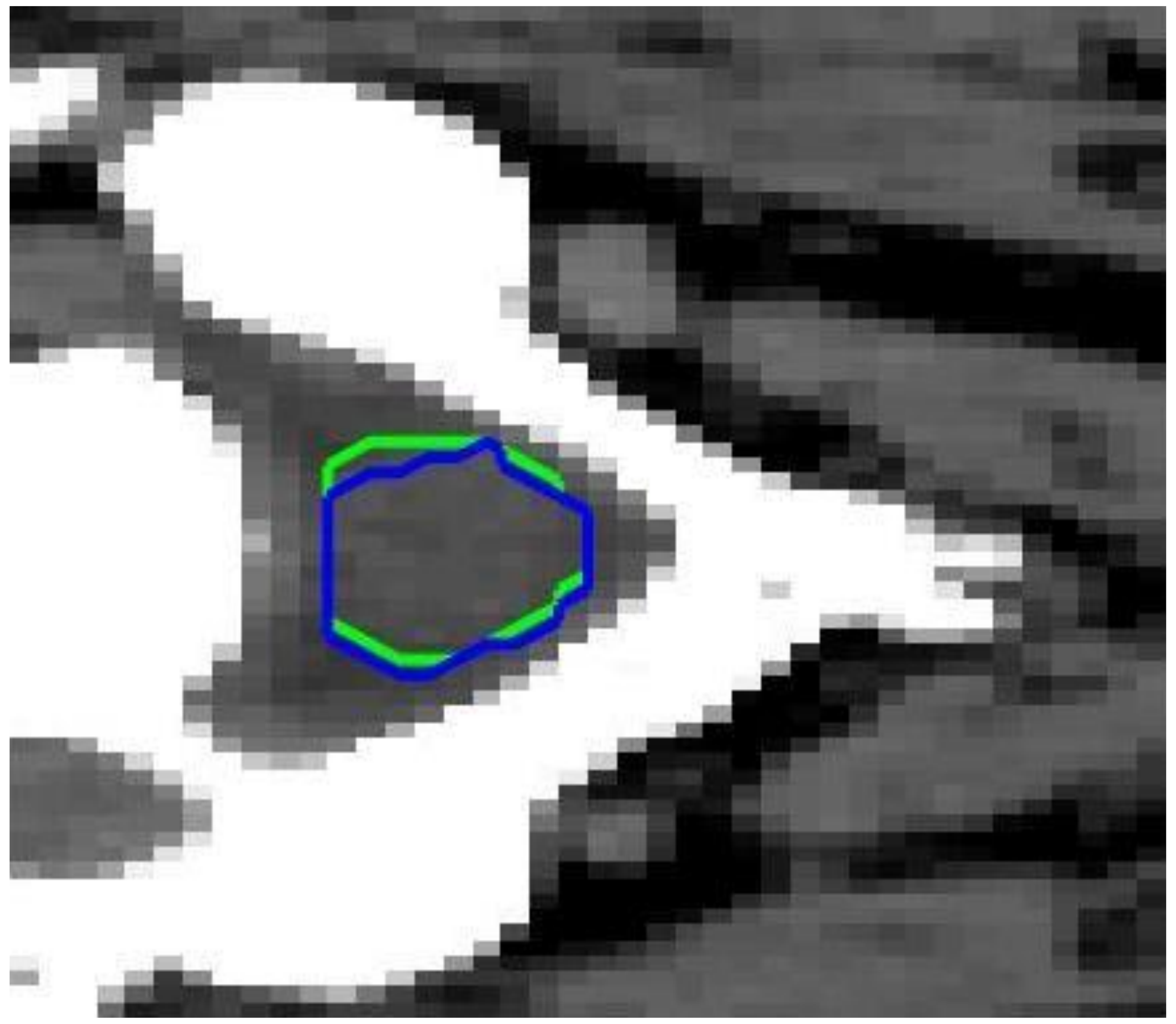


Figure. Accuracy of linear and data-driven interpolation in terms of DSC, as the slice spacing is varied. Similar results are also presented for the brainstem, submandibular glands, parotid glands, and hyoid.



LI EXAMPLE



DDI EXAMPLE

CONCLUSIONS

There are significant improvements for the cord (shown, left) and the hyoid, where DDI consistently outperforms LI. For structures with minimal contrast (brainstem and submandibular glands) on the known contours, the performance is similar for each method. However, there is some minor improvement for DDI as slice spacing increases for the parotid glands.

By utilising user-provided data, interpolation methods can achieve improved results for some structures in the head and neck. DDI incorporates manually acquired contours from multiple views and potentially offers significant advantages in terms of interactivity, and flexibility in terms of OAR considered compared to LI. This highlights the benefits of using DDI to supplement manual contouring approaches. LI is a commonly used clinical tool in this setting, and DDI is applicable in a similar framework.

The proposed algorithm is capable of exploiting knowledge of the provided contours to reduce the requirements on the user. This can either consist of achieving a similar accuracy with reduced input, or an improved accuracy with the same input. In a clinical setting this could be useful with respect to contour acquisition time.

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