Clinical evaluation of a fully automatic body delineation algorithm for radiotherapy

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Purpose:
The aim of radiotherapy is to deliver the highest possible dose to the tumour and spare surrounding healthy tissue. For high efficacy an accurate delineation of the body outline on planning CT is crucial. However, depending on the tumour and treatment type, positioning markers, implanted catheters (brachytherapy), air bellow belt, fixation mattress, table and/or blankets are directly adjacent to the patient’s skin. Algorithms currently employed in clinical settings often cannot distinguish those devices and include them in the body segmentation which requires tedious manual corrections. In this work, a fully automatic algorithm for body delineation which can handle structures adjacent to the patient is clinically evaluated for various cancer cases.

Methods:
For testing a MITK platform implementation of the previously published algorithm [1] was used. For evaluation purposes, segmentation was performed on the planning CT of 30 patients:

- 10 lung cancer patients,
- 10 patients with a prostatic lesion and
- 10 rectum carcinoma patients.

CT scans were acquired on different scanners with highly varying image features. Body delineations used for real treatment planning served as reference contours.

Results:
The following figures of merit were obtained:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Volume ratio</td>
<td>0.99 ± 0.006</td>
</tr>
<tr>
<td>Falsely classified pixels</td>
<td>0.28 ± 0.18 %</td>
</tr>
<tr>
<td>Dice’s coefficient</td>
<td>0.99 ± 0.002</td>
</tr>
<tr>
<td>Hausdorff distance</td>
<td>6.02 ± 3.42 mm</td>
</tr>
<tr>
<td>Runtime</td>
<td>16.8 ± 6.23 seconds</td>
</tr>
</tbody>
</table>

For all cases the algorithm was able to successfully separate the body from adjacent parts like markers, blankets, mattress without user interaction.

Conclusion:
We have presented a fully automatic algorithm for body delineation that can handle structures adjacent to the patient. Evaluation on 30 clinical cases demonstrated a very good performance and an excellent agreement with respect to reference contours. Results suggest the suitability of the algorithm for clinical use with cases of the tested region between thorax and pelvis. Future work will explore the use of the algorithm for other body regions.