Purpose: Anatomical segmentation remains the most time-consuming task in radiotherapy planning. Atlas-based segmentation methods using deformable registration emerged as a practical approach to automate the process for head and neck anatomy, but it poses significant challenges in thoracic and pelvic regions where large inter-patient variations are present. We present an approach combining diffeomorphic inter-modality deformable registration with level-set based refinement for an accurate atlas-based segmentation of CT scans.

Methods: Our automated approach involves a multi-atlas matching stage followed by a per-organ refinement. At the atlas matching stage, multiple atlases are matched to the patient anatomy to determine a rough segmentation using a new non-parametric multi-modality diffeomorphic deformable registration algorithm able to cope with differences in contrast, bowel filling, and artifacts. A probabilistic map of organ shape and locations is constructed from each atlas mapping using the STAPLE algorithm, followed by a refinement procedure using variants of level-set algorithms customized for each organ. Validation was performed by comparing results against clinical manual segmentations using the Dice coefficient

Results: Dice comparison with manual segmentation measured on 20 clinical cases ranged 0.89-0.92 for liver, 0.91-0.93 for kidneys, 0.94-0.96 for spleen 0.87-0.92 for heart and 0.87-0.92 for the spinal cord. The algorithm is fully automated, running as a software service in the background without any user interaction

Conclusions: Automated segmentation accuracy for abdominal and thoracic regions is affected without a multi-atlas and per-structure refinement strategy. The process significantly decreases segmentation times improving clinical workflow and efficiency as segmentations of normal tissue are automatically performed immediately after image acquisition.