

Bronchial Correlation Objects for Improved Tumour Localisation on Stereoscopic X-ray Images

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Motivation

- Challenges for lung gross-tumour-volume (GTV) localization on X-ray images in radiotherapy:
 - Low imaging contrast
 - Anatomical overlaps (i.e. heart or ribs)
- Novel concept:** Bronchial structures around the GTV, that move similarly to the GTV, as a surrogate for GTV localization (Correlation Objects (COs) [1]).

Aim

Assessing the Correlation Object-based GTV localization accuracy

Patient Cohort

- Retrospective patient cohort of 131 patients (63 Female & 69 Male) with mean age of 70 years
- 4D computed tomography (4DCT) images with 10 phases.
- Mean (Range) GTV volume: 5.0 (0.1 – 458.0) cm³
- Mean GTV centre-of-mass (COM) amplitude: (8.3 ± 5.8) mm

Workflow steps (Figure 1)

- 4DCTs of patient cohort** were retrospectively collected.
- X-rays simulation** based on the Beer-Lambert law using calibrated geometry, attenuation coefficients, incident intensities and spectrum for a BrainLab ExacTrac Dynamic system (Brainlab SE, Germany). Imaging settings: 110kV and 16mAs
- Voxel-wise motion information** was calculated in the lung contours using deformable image registration across all 4DCT phases.
- Threshold (motion margin) definition** between 0 mm and the patient-specific maximum. Lung voxels with a motion deviating less than the defined motion margin from the GTV motion were grouped to a CO. (Brainlab pilot software)
- Registration to simulated X-rays** of COs with varying sizes [2]. COs from each 4DCT-phase were registered to simulated X-rays from each 4DCT-phase. Comparison of registered GTV position to ground truth (4DCT GTV contour) and GTV COM localization error calculation.

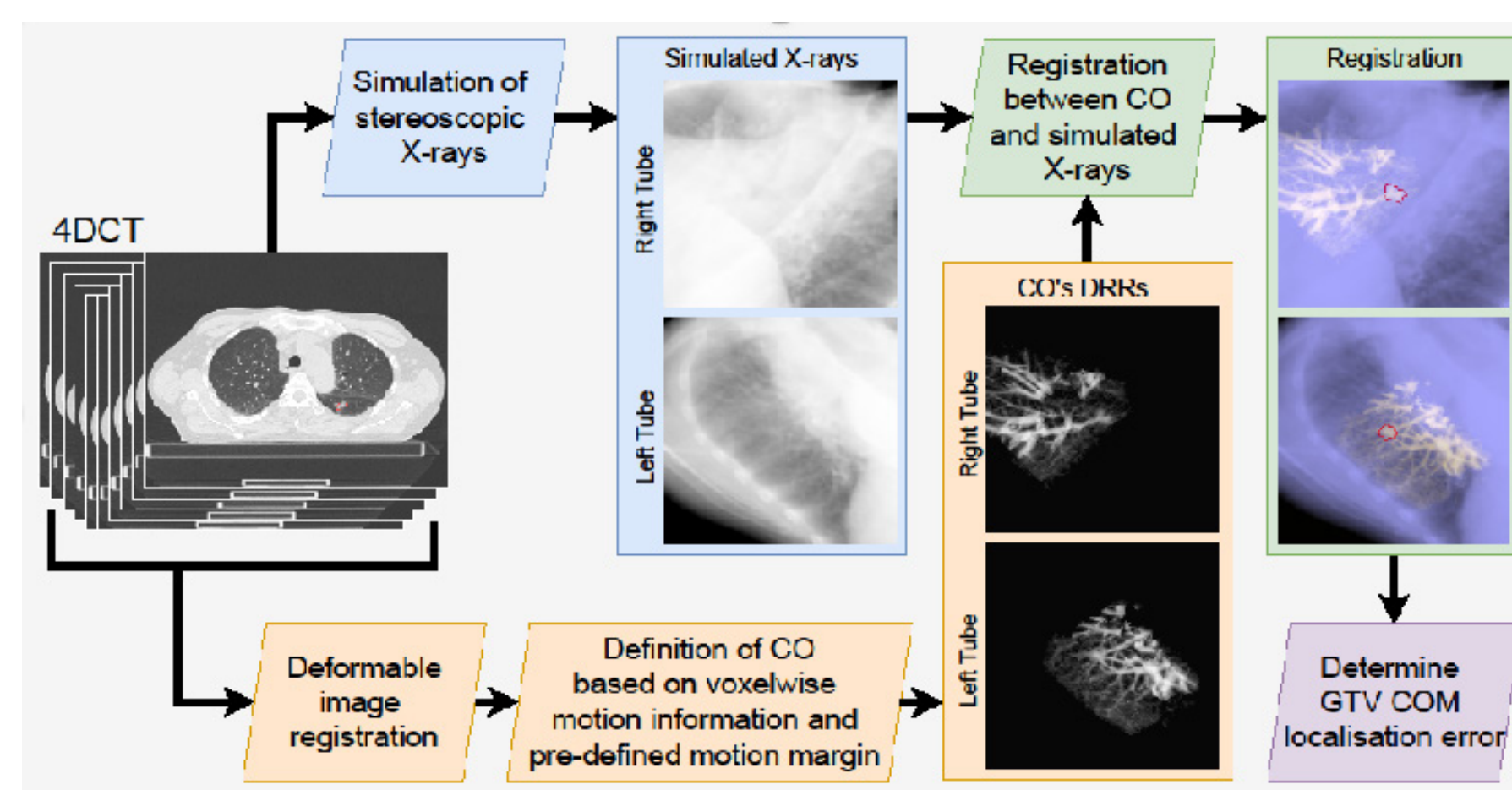


Figure 1 Workflow overview

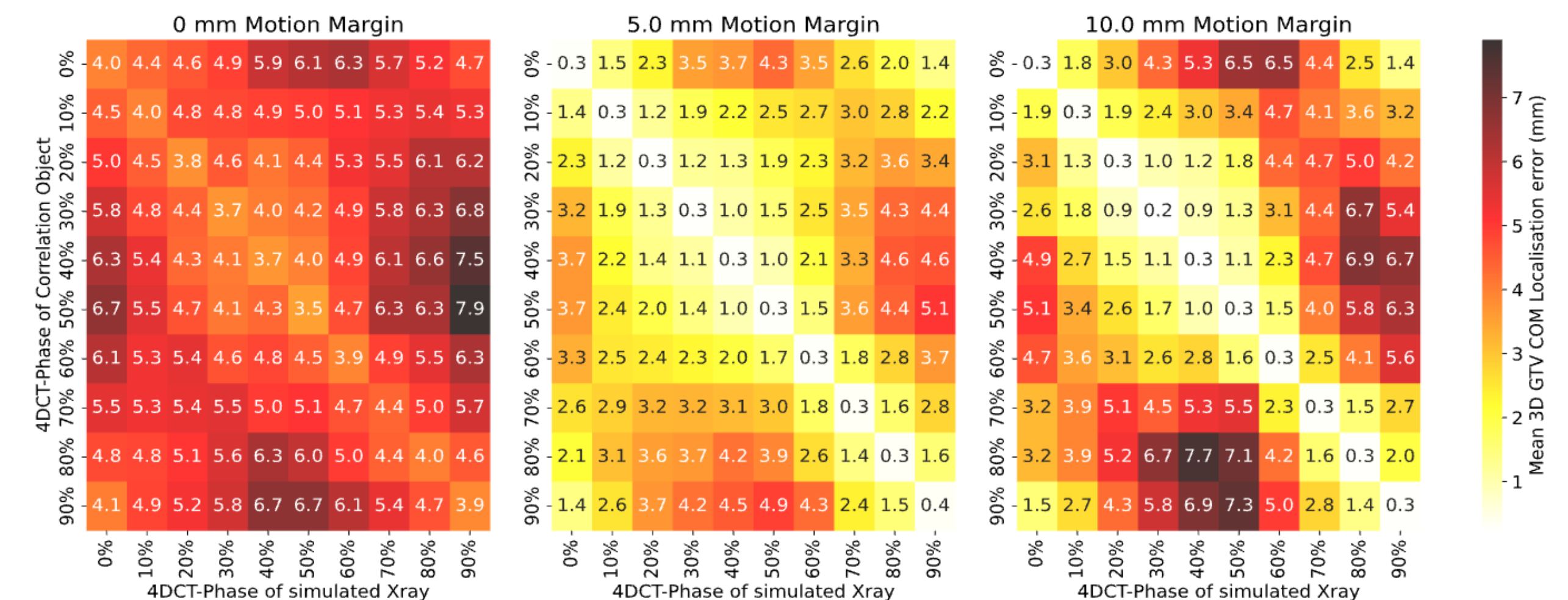


Figure 2 3D GTV COM localization errors registering COs from each 4DCT-phase to simulated X-rays from each 4DCT-phase for 0 mm, 5 mm, and 10 mm motion margins

Results & Discussion

CO and X-ray from same 4DCT-phase (diagonal elements)

In this idealized case, localization errors decreased with increasing motion margin as more anatomical information was added, aiding the registration. Residual localization errors of (0.2 ± 0.1) mm remained even for the largest COs.

CO and X-ray from different 4DCT-phases (Off-diagonal elements)

While larger COs reduce the localization error at first, they eventually lose accuracy by becoming too specific to the anatomy of the CO's 4DCT-phase.

Conclusion & Outlook

- The results showed the importance of selecting robust motion margin for CO-size
- Determine localization errors could be used for planning-target volume margin concept

Acknowledgments

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References

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