Day-Of Lung Cancer Motion Verification on kV-CBCT Projections via Tumour Decomposition with Deep Learning

T. Yau[1,2], E. Wang[1], S. Gaede[1,2]
[1] Department of Medical Biophysics, Western University, London, Canada
[2] Department of Physics and Engineering, Verspeeten Family Cancer Centre, London, Canada

INTRODUCTION

- Thoracic tumours frequently present with breathing-induced motion, complicating radiotherapy
- Appropriate motion management is required to ensure target coverage and minimize radiotoxicities
- While motion management is determined at treatment simulation, **the 1–2-week delay to treatment can manifest motion pattern variations**[1]
- Day-of motion assessment is critical to accurate radiotherapy
- Motion assessment using on-board kV imagers allows for day-of motion verification, but suffers from poor tumour contrast

A tumour decomposition technique could enhance tumour contrast on 2D kV images for automatic tumour tracking

OBJECTIVE

To investigate the feasibility of a deep learning workflow for tumour decomposition on 2D kV images

METHODS

- Pre-treatment cone-beam CT were used to simulate tumourless digitally reconstructed radiographs (DRRs)
- A U-Net was trained to learn a DRR-to-kV pixel mapping using a **contrastive learning**[2] technique illustrated in **Fig 1**.
- 57 treatment fractions across 14 early-stage lung cancer patients were prospectively collected for a total of **20 520 kV projections**
- Ground-truth segmentations were manually contoured on fractions with visible lesions for testing (n = 15) and trained on the remaining images

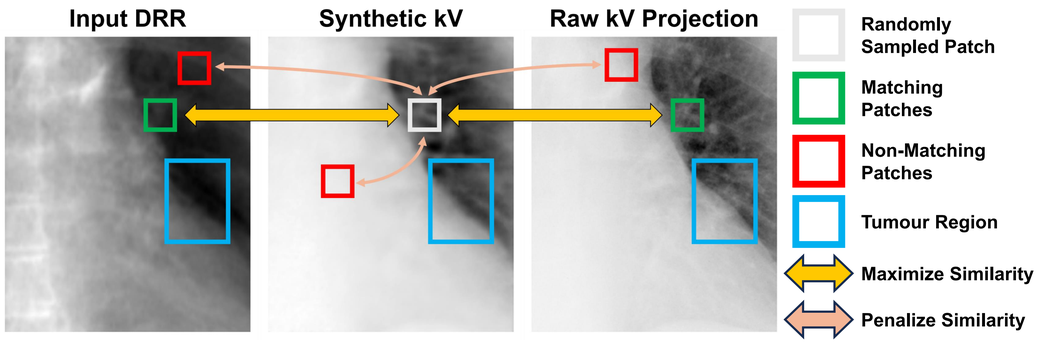

Figure 1: *The model performs a DRR-to-kV pixel mapping by learning to distinguish between corresponding and non-corresponding image patches in both DRRs and kV image domains*

- Binary thresholding + contrast enhancement was benchmarked against DRR-based decomposition[3] and adaptive histogram equalization (AHE)

TUMOUR DECOMPOSITION WORKFLOW

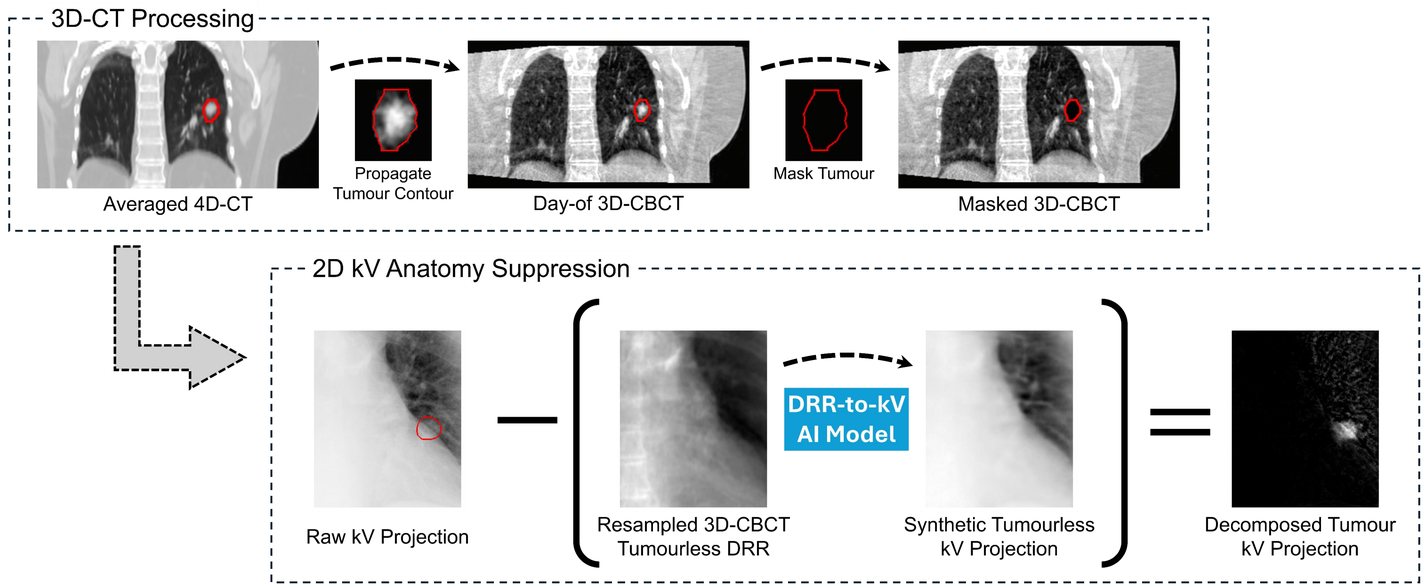

Figure 2: *A synthetic tumourless kV projection is generated for each corresponding true kV acquired pre-treatment and subtracted to suppress the overlapping anatomy and enhance tumour contrast*

RESULTS

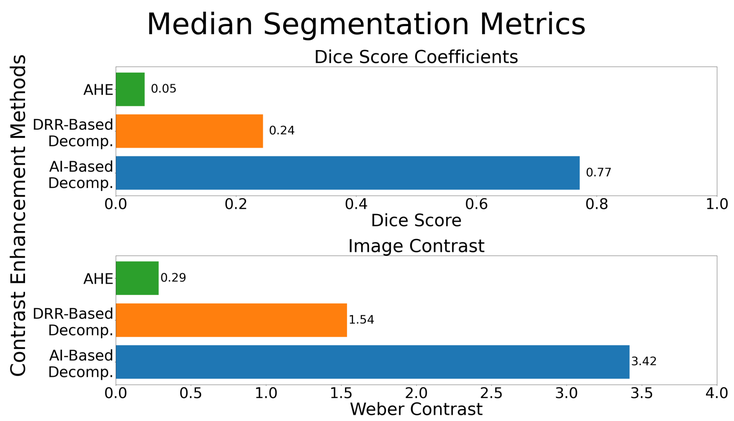

Figure 3: *Comparison of contrast enhancement techniques show our workflow outperforms traditional methods*

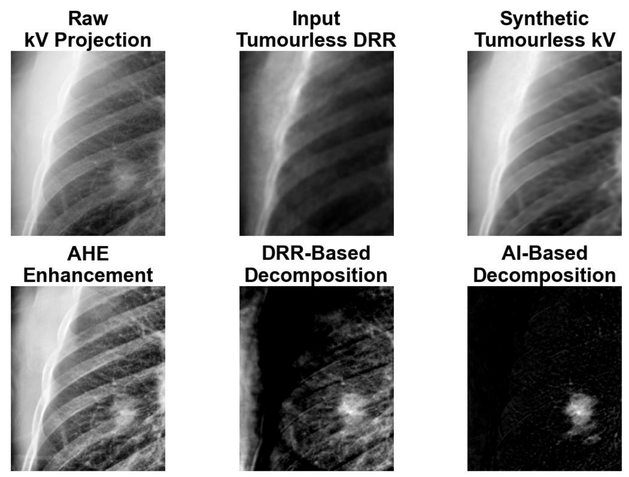

Figure 4: *Qualitative comparisons of different contrast enhancement techniques for a sample patient*

CONCLUSIONS

- Our workflow can achieve superior tumour contrast on 2D kV images
- Future work will extend this workflow from pre-treatment motion verification to real-time tumour tracking

REFERENCES

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NSERC CRSNG
LAWSON HEALTH RESEARCH INSTITUTE

CONTACT INFORMATION

Timothy Yau (tyau5@uwo.ca)
Stewart Gaede (Stewart.Gaede@lhsc.on.ca)