Ultrasound-based motion modelling is a feasible approach to estimating **lung motion** variabilities and their effects on **proton dose distributions**.

Liver-ultrasound based motion modelling to estimate 4D dose distributions for lung tumours in proton therapy

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Introduction

- Motion mitigation is crucial for scanned proton therapy of mobile tumours to prevent
  - geometrical target miss,
  - interplay effects, and thus
  - under- and overdosage.
- We present a patient-specific respiratory lung motion model based on hybrid 4D MRI and 2D abdominal ultrasound (US) imaging.

Methods

- Simulation study based on 10 combined CT/4D MRI data sets using
  - respiratory motion characteristics of 5 healthy volunteers,
  - fused with the CT data of 2 lung cancer patients.
- Gaussian process regression is used for estimating full lung motion information given a US image of the liver and the diaphragm.

Results

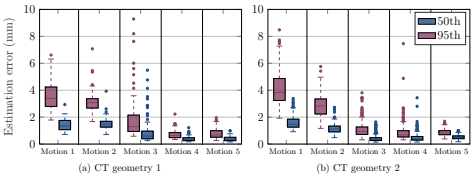

Fig. 1 Geometrical analysis: Error percentiles of voxels within the VOI.

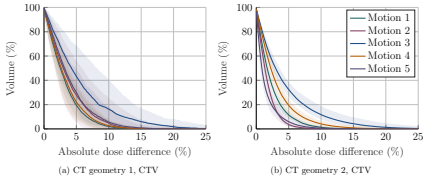

Fig. 2 Dosimetric analysis: Dose difference volume histograms.

Conclusion

This approach offers the possibility to take into account motion variabilities in 4D treatment planning, retrospective dose reconstruction, and online beam tracking.

Additional figures

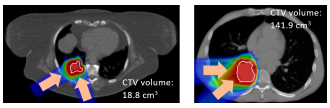

Fig. 3 CT geometries and beam directions.

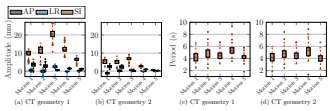

Fig. 4 Respiratory motion characteristics.

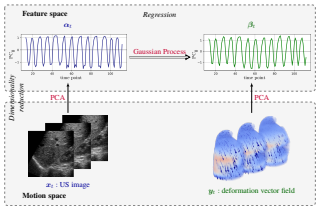

Fig. 5 Respiratory motion model.

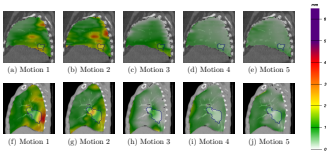

Fig. 6 Geometrical error, averaged over time.

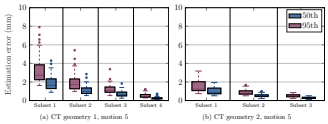

Fig. 7 Drift analysis.

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This work was supported by the Swiss National Science Foundation, SNSF (project number: 320030_163330/1).

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