MR SIGNATURE MATCHING (MRSIGMA) WITH MOTION BASELINE DRIFT ADAPTATION FOR REAL-TIME VOLUMETRIC MOTION TRACKING

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Introduction

- **MRI-guided adaptive radiotherapy is the next leap in treatment of tumors affected by physiologic motion**
- **However, current MRI technology cannot deliver real-time volumetric imaging to track tumor motion**
  - **"real-time" is defined as low imaging latency (acquisition + reconstruction) with respect to motion. For respiratory motion, a latency of 300ms is usually required.**
- **Our group has recently introduced MR SIGnature MAtching (MRSIGMA) for real-time volumetric imaging, where a database of motion states and signatures is pre-learned during an offline training phase, and real-time signature acquisition and matching is performed during an online matching phase However, MRSIGMA is sensitive to anatomical changes during the online matching phase, i.e. motion baseline drifts, which can severely affect the accuracy of motion tracking.**
- **In this work, we present a new version of MRSIGMA that detects and adapts for motion baseline drifts in real-time, and test initial feasibility on free-breathing liver datasets with simulated motion baseline drifts.**

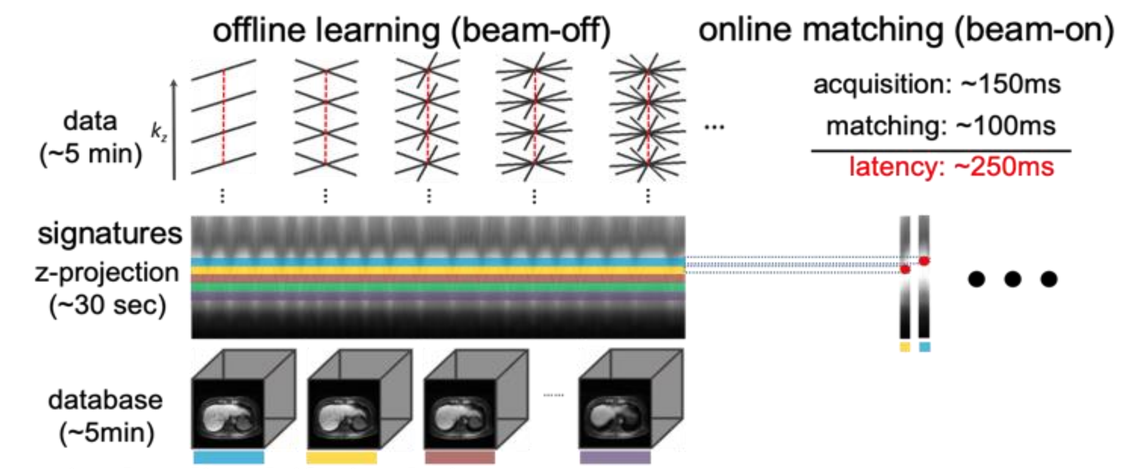
Methods

Data acquisition:

- **Free-breathing liver MRI was performed on a 3T scanner (Philips Ingenia) using the 3DVANE pulse sequence, which uses a golden-angle stack-of-stars k-space trajectory. Acquisition was performed using 1792 spokes and 50 kz points for 8.5 minutes.**

Standard MRSIGMA:

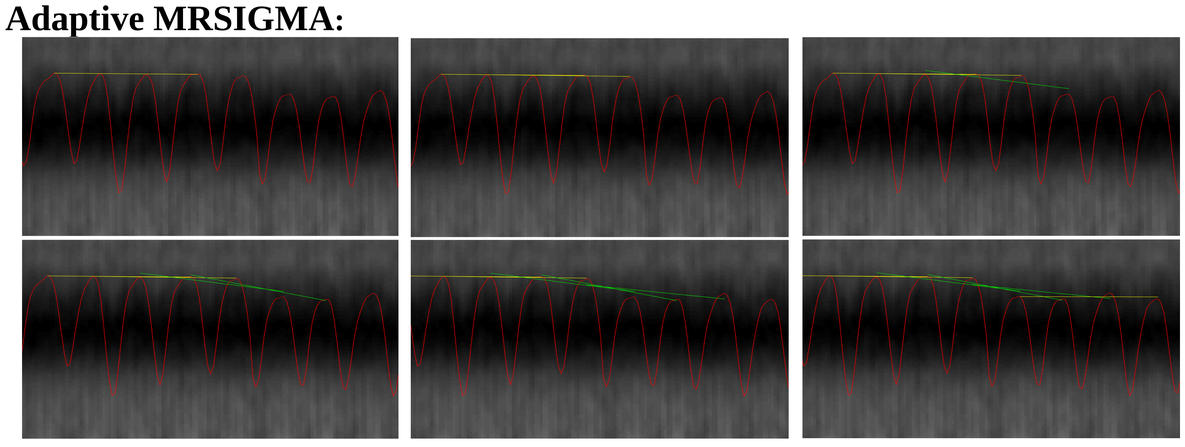
- **For offline learning: a database of high-resolution 3D motion states was computed using XD-GRASP reconstruction.**
- **Online matching was performed by acquiring signature data only and matching it with the corresponding database entry.**



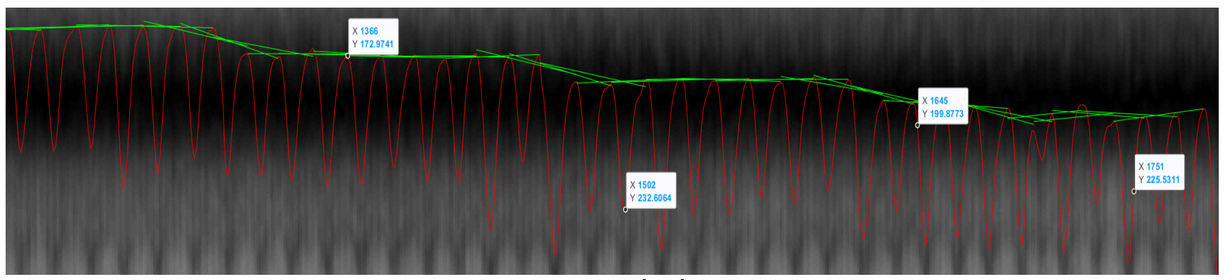
Motion baseline drift simulation:

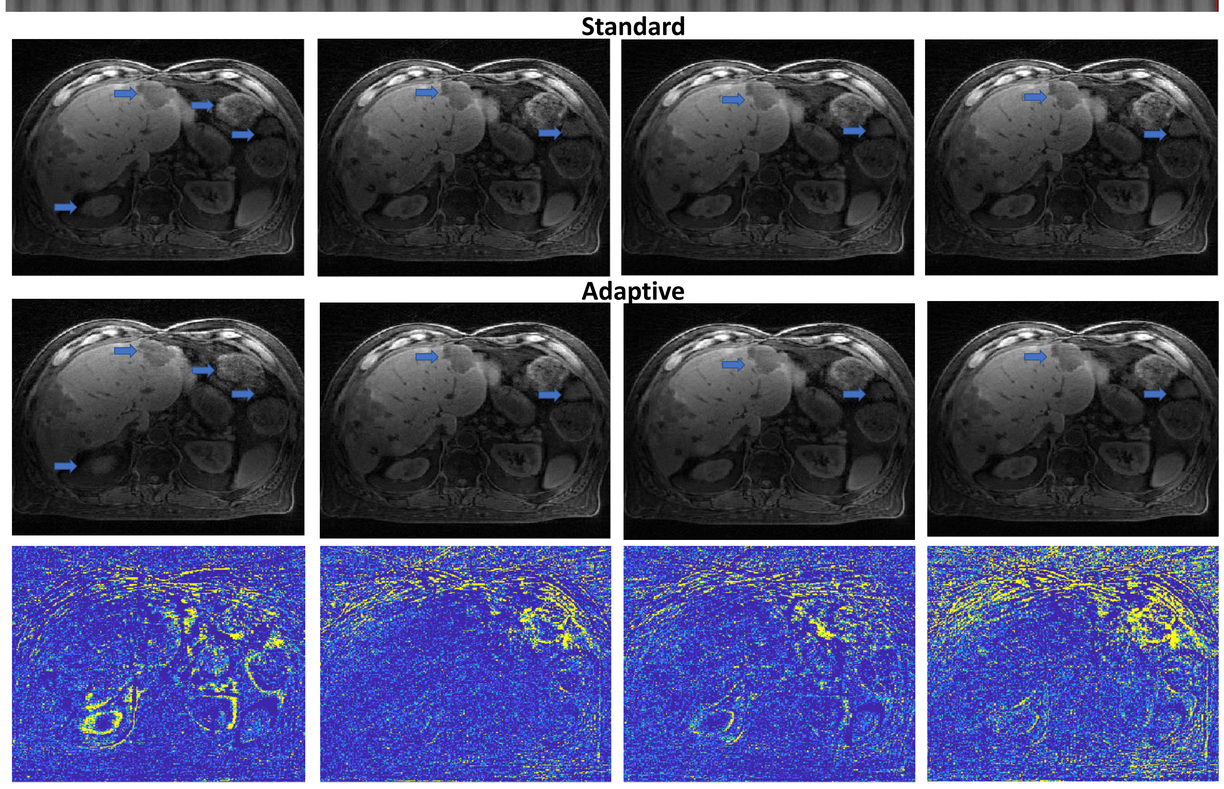
- **Data corresponding to the online matching step (last 542 spokes) were shifted along the z direction to represent different baseline drifts**

Adaptive MRSIGMA:



Results





- **For the particular dataset used in this work, offline learning was performed using the first 1250 spokes to generate a database of ten 3D motion states and online matching was performed using the last 542 spokes. Online matching has a total imaging latency of 240ms, given by the acquisition latency of 200ms (one spoke with TR=4ms and 50 kz points) and the signature matching latency of 40ms.**
- **The detection and adaptation procedure added 50ms to our latency.**

Discussion

Adaptive MRSIGMA addresses a previous limitation of MRSIGMA given by the presence of respiratory motion baseline drifts that can occur overtime in radiotherapy sessions. Rapid adaptation of the signature matching procedure can improve robustness of MRSIGMA for real-time volumetric motion tracking using a MR-Linac for adaptive radiotherapy of moving organs.

References

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