



HAL
open science

Real-time estimation and characterization of physiological organ deformations for MR-guided interventional therapies

Baudouin Denis de Senneville, Abdallah El-Hamidi, Chrit Moonen

► **To cite this version:**

Baudouin Denis de Senneville, Abdallah El-Hamidi, Chrit Moonen. Real-time estimation and characterization of physiological organ deformations for MR-guided interventional therapies. IEEE International Symposium on Biomedical Imaging (ISBI), Apr 2015, New-York, United States. hal-01163517

HAL Id: hal-01163517

<https://hal.science/hal-01163517>

Submitted on 13 Jun 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

REAL-TIME ESTIMATION AND CHARACTERIZATION OF PHYSIOLOGICAL ORGAN DEFORMATIONS FOR MR-GUIDED INTERVENTIONAL THERAPIES

B. Denis de Senneville, A. El Hamidi, and C. T. W. Moonen,

ABSTRACT

Recent developments in rapid Magnetic Resonance Imaging (MRI), associated with fast image processing techniques allow acquiring functional and positional information in real-time, which can be conveniently used on-line to control a cancer therapy, using High Intensity Focused Ultrasound or Radio Therapy. Real-time image-based strategies are currently under active development for motion estimation of abdominal organs and for correcting motion related artifacts.

1. INTRODUCTION

Real-time processing of MR-images, combined with a High Intensity Focused Ultrasound system (MR-HIFU) with electronic displacement of the focal point, can be used to achieve a regional temperature control [1]. Similarly, the recent development of integrated MRI linear accelerators (MR-LinAc), designed for simultaneous irradiation and MR-imaging, shows great potential for on-line radiotherapy guidance.

Although these new techniques appear well suited for cancer therapy in vital organs such as kidney and liver, physiological displacements induced by breathing and/or cardiac activities require a precise real-time motion management to ensure: 1) A correction of motion-induced image artifacts (in particular, MR-susceptibility variations generate apparent temperature perturbations in the case of MR-HIFU, as well as geometric image distortions in the case of both MR-HIFU and MR-LinAc); 2) An accurate calculation of the accumulated dose (based on MR-thermometry for thermal dose assessment with MR-HIFU or dose simulations with MR-LinAc); 3) A reliable beam targeting of the pathological tissue.

Fast MR-acquisition protocols allow acquiring dynamically 2D images with a good contrast which can be conveniently used to estimate organ displacements during the therapy using image registration algorithms¹. In addition, strate-

gies are being developed to correct motion artifacts on-line, based on the quantitative and real-time characterization of individual physiological contributions such as breathing and cardiac activities [2].

2. RESULTS

Fig. 1 reports a Principal Component Analysis (PCA) approach which detects, in a preparative learning step, spatio-temporal coherences in the targeted organ motion. During thermometry, incoherent motion patterns were discarded to improve the robustness of the motion estimation process and the compensation of motion related errors in thermal maps.

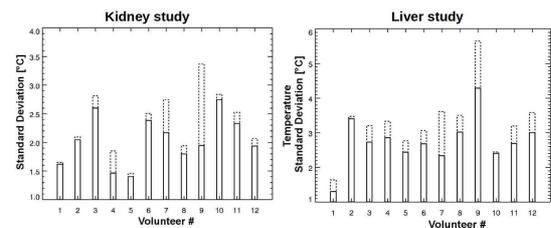


Fig. 1. Temperature precision obtained in the abdomen of twelve volunteers when the temperature maps were computed using an affine motion model (dash line) and the tested PCA-based description (solid line).

3. CONCLUSION

Recent developments open great perspective to address both target tracking and compensation of motion artifacts by applying high frame rate MRI coupled with a real-time motion characterization obtained from all incoming images.

4. REFERENCES

- [1] R. J. Stafford et al., “Magnetic resonance temperature imaging for focused ultrasound surgery: a review,” *Top Magn Reson Imaging*, vol. 17(3), pp. 153–63, 2006.
- [2] B. Denis de Senneville et al., “A direct PCA-based approach for real-time description of physiological organ deformations,” *IEEE Trans on Medical Imaging*, vol. 34(4), pp. 974–982, 2015.

The authors thank the European Research Council (Sound Pharma) and the Dutch Technology Foundation (Ontrack) for funding.

B. Denis de Senneville and C. T. W. Moonen are with the Imaging Division, UMC Utrecht, Netherlands, (e-mail: {b.desenneville,c.moonen}@umcutrecht.nl).

B. Denis de Senneville is also with the IMB, UMR 5251 CNRS/University of Bordeaux, F-33400 Talence, France.

A. El Hamidi is with the “Laboratoire des Sciences de l’Ingénieur pour l’Environnement”, Université de La Rochelle, France, (e-mail: aelhamid@univ-lr.fr).

¹<http://bsenneville.free.fr/RealTITracker/>