

# Breathing motion estimation from 2D x-ray projections



<https://www.creatis.insa-lyon.fr/site7/fr/node/45911>

## Context

Breathing motion is a known problem in radiotherapy that has been a subject of intense investigations in the past 15 years. It impacts every step of the treatment, e.g., during image acquisition in the treatment room using a cone-beam computed tomography (CBCT) scanner. Several solutions have been proposed to improve CBCT images of the thorax, including motion-compensated or motion-aware reconstruction techniques [4, 5] which use an estimate of the motion during the acquisition.

## Objective

The purpose of this master internship is to improve image quality by refining the estimate of the breathing motion during the CBCT acquisition. To that end, we propose to use a 5D motion model [1, 2]. A collaboration with Jamie McClelland of CMIC (<http://cmic.cs.ucl.ac.uk/>) is planned where this model has been applied to several other modalities (see, e.g., [3]).

## Tasks

- Implement 2D/3D motion estimation using the 5D model,
- Implement motion-compensated reconstruction using the 5D model,
- Evaluate the result on real data acquired at the Léon Bérard center (Lyon).

## Required skills

- **Education:** master student in image processing or medical physics.
- **Scientific interests:** computer sciences (medical image processing), x-ray physics.
- **Programming skills:** Matlab, C++ (ITK, RTK).
- **Languages:** English required, French optional.

## Practical information

- **Supervision:** Cyril Mory, Simon Rit and Jamie McClelland
- **Location:** Mainly at the Centre Léon Bérard, Lyon, France.
- **Period:** 2017 (duration negotiable).
- Send CV and a brief statement of interest by email to Simon Rit ([simon.rit@creatis.insa-lyon.fr](mailto:simon.rit@creatis.insa-lyon.fr)).

## References

- [1] J. Liu, X. Zhang, X. Zhang, H. Zhao, Y. Gao, D. Thomas, D.A. Low A, and H. Gao. 5D respiratory motion model based image reconstruction algorithm for 4D cone-beam computed tomography. *Inverse Problems*, 31(11):115007, 2015.
- [2] D.A. Low, P.J. Parikh, W. Lu, J.F. Dempsey, S.H. Wahab, J.P. Hubenschmidt, M.M. Nystrom, M. Handoko, and J.D. Bradley. Novel breathing motion model for radiotherapy. *Int J Radial Oncol Biol Phys*, 63(3):921–929, Nov 2005.
- [3] J.R. McClelland, D.J. Hawkes, T. Schaeffter, and A.P. King. Respiratory motion models: A review. *Med Image Anal*, Oct 2012.
- [4] C. Mory, G. Janssens, and S. Rit. Motion-aware temporal regularization for improved 4D cone-beam computed tomography. *Phys Med Biol*, 61(18):6856–6877, Sep 2016.
- [5] S. Rit, J.W.H. Wolthaus, M. van Herk, and J.-J. Sonke. On-the-fly motion-compensated cone-beam CT using an a priori model of the respiratory motion. *Med Phys*, 36(6):2283–2296, Jun 2009.