DEFORMABLE IMAGE REGISTRATION IN PROSTATE CANCER IMAGE-GUIDED ADAPTIVE RADIOTHERAPY

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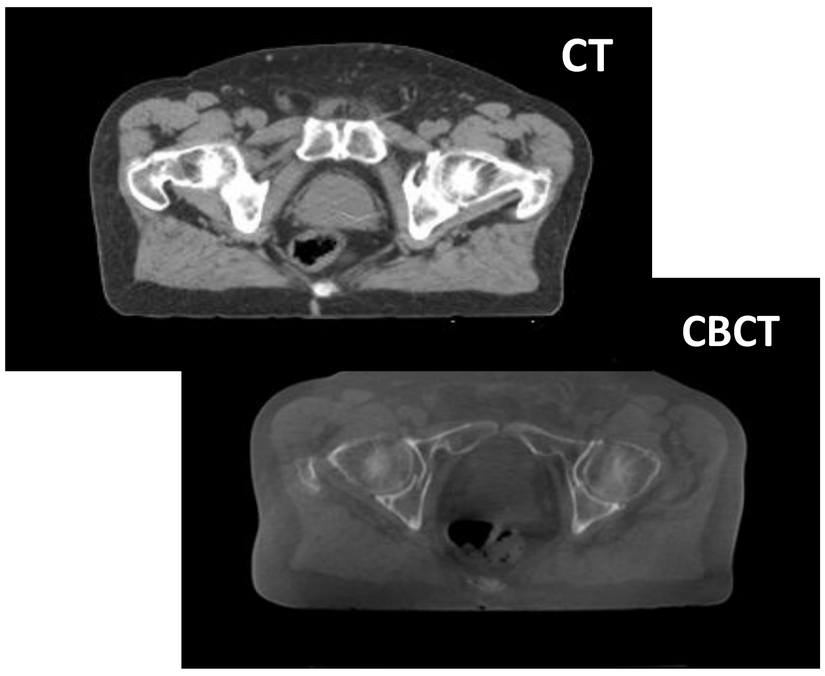
Introduction

In radiation therapy, the development of in-room imaging systems such as cone beam computed tomography (CBCT) allows to localize organs of interest at treatment day, and perform a more accurate dose delivery after registration of the planning CT and the daily CBCT scans. Using CT/CBCT deformable registration (DR) at this stage also allows dose plan updates during treatment course. CT/CBCT DR in the pelvic region is challenging due to the poor image quality of CBCT scans. We developed a joint registration and segmentation algorithm that integrates active contours (level sets) and a Bspline deformable transform in a variational framework.



Material and methods

Clinical data:

- 10 prostate cancer patients
- 1 planning CT scan per patient manually delineated for clinical requirements
- Between 8 and 20 daily CBCT scans per patient:

a radiation oncologist was asked to manually delineate the clinical target volume (CTV) on each CBCT scan for the purposes of this study

Registration algorithm:

- Based on ITK image processing library (C++)
- Joint registration and segmentation framework
- Variational approach (resolution using Euler-Lagrange equation and gradient descent)
- Minimisation of the following energy:

$$E = E_{segmentation} + E_{registration}$$

$$= E_{active\_contours} + E_{shape\_a\_priori} + E_{Normalized\_cross\_correlation}(I_{CBCT}, I_{CT} \circ D) + E_{smooth\_deformable}$$

where D is the deformable transform (maps points from the physical space of the fixed image (CBCT) into the physical space of the moving image (CT)). D is to be optimized.

Validation:

Calculation of a simiarity coefficient which measures the overlap between the automatic CBCT segmentations (obtained after propagation of the CT segmentations) and the manual CBCT segmentations (eg, Dice coefficient).
Calculation of a distance between these segmentations (eg, Hausdorff-derived distance).

Results to come…

The obtained deformation field that maps the CBCT scan into the CT scan will allow us to perform a dosimetric study.