A multimodality registration application for external beam radiotherapy

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Abstract. Combining the patient's 3D computed tomography (CT) dose planning scan with radiotherapy (RT) session image recordings, we develop a novel technique to track the patient's body motion. A multimodal registration algorithm allows to quantify three-dimensional movements, providing a tool to control and correct patient positioning.

Keywords: Image-guided radiotherapy · Multimodality image registration · Computer vision in healthcare.

Extended Abstract

Motivation and Objectives

State-of-the-art radiotherapy devices take into account patient motion and volumetrical changes of the organs to reduce geometrical uncertainties. This allows an appropriate dose escalation without compromising surrounding healthy tissues. Proven medical solutions that exploit multimodal images and signals along time became an useful, though expensive, tool for radiotherapy. Our proposal consists in combining real time images of RT patient sessions and planning CT scans, in order to provide further information about body motion. This can be helpful for re-positioning the patient and gated RT techniques, among other facilities, without the need of invasive devices such as fiducial markers or spirometers.

Application Scheme and Materials

Figure 1 shows the application flow scheme. The parameters to be acquired are the position, orientation and inner configuration of each camera in the RT room, as well as the CT scan spatial coordinates. With this information, the three-dimensional volume can be projected into different perspective views, coherent with the camera images. Patient motion estimation is computed using one registration process between each pair of images. Each pair is composed by one frame a video camera and one projection from the planning CT scan. On

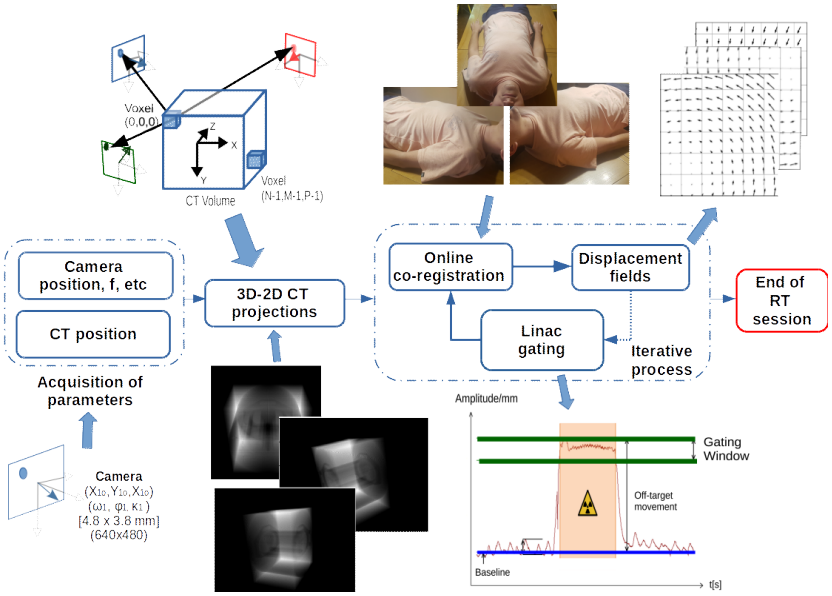

Fig. 1. Possible application flow scheme. After preprocessing the camera parameters and 3D scan, an iterative process computes the displacement fields. These provide information to the RT operator and accelerator for position correction and RT gating, respectively.

each loop, the displacement fields are calculated and displayed, result of the registration algorithm's optimisation. With this information, we can quantify the target displacements and trigger the dose dispensing. Still though, linear accelerator gating has not been implemented yet.

Computational Tools and Future Work

The proposed device is being developed entirely in `Python`, which allows the usage of several libraries for image processing and analysis. For medical image file handling and processing, we use `SimpleITK`, an easy to use biomedical interface to ITK. With respect to the cameras configuration and calibration, `OpenCV` provides specific I/O tools over which we built our own methods. We are currently working on validating this application on digital and physical phantoms. Finally, an accurate measure of body motion can be use to trigger dose dispensing, gating the linear accelerator when an unusual movement is detected.