close window

Print

Submitted Abstract

on April 11, 01:44 AM

for Astro

Abstract Proof

CONTROL ID: 149637

CONTACT (NAME ONLY): David Sarrut

Abstract Details

PRESENTATION TYPE: Oral or Poster

CATEGORY: Radiation Physics

SUB-CATEGORY: Lung Cancer

KEYWORDS: deformable registrat, lung, respiratory motion.

AWARDS:

Abstract

TITLE:
Simulation of 4D CT images from deformable registration between inhale and exhale breath-hold CT scans

AUTHORS (ALL): Sarrut, David [1, 2]; Boldea, Vlad [2, 1]; Miguet, Serge [2]; Ginestet, Chantal [1].

INSTITUTIONS (ALL): 1. radiotherapy, Leon Berard anticancer center, Lyon, France.
2. LIRIS laboratory, Universite Lumiere Lyon 2, Lyon, France.

ABSTRACT BODY:

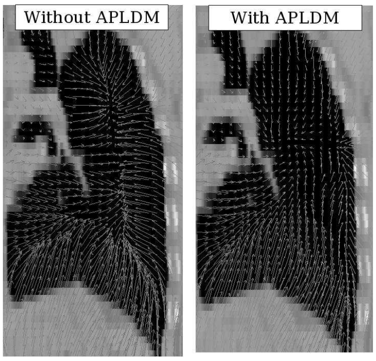
Purpose/Objective: We propose to simulate a 4D CT image of thorax during breathing from two CT scans acquired at inhale and exhale breath-hold.

Materials/Methods: The 4D image was built by deformable registration, vector field interpolation and image resampling. For deformable registration, similarity measure was sum of square difference (SSD), optimization method was gradient descent. Second order approximation of SSD’s gradient was used. Gaussian and linear elastic (LE) regularizations were compared. Intensity conservation assumption is not strictly verified in lung because the quantity of air inspired leads to a decrease of lung density. Hence, a new method, named a priori lung density modification (APLDM), was proposed. It consisted to artificially change the lung density of one image according the the other. To obtain intermediate thorax position, we considered the linear pathway of each particle along its displacement vector. Link between vector field interpolation and temporal respiratory instant was done according to lung volume extracted from images and respiratory signal acquired with ABC device. Finally, intermediate CT images were generated by way of Jacobian-based lung densities generation, which consisted in locally modifying voxel density according to the Jacobian of the deformation and the voxel air content.

Results: Experiments were performed on 4 patients, for which three 3D CT images were acquired in breath-hold, with ABC device. The three images were acquired at about 0.2L below normal expiration (BH1), about 0.2L above normal inspiration (BH2) and at about 70% of total lung capacity (BH3), according to patient ability. 48 deformation fields were computed at a resolution of 2.5mm (4 millions of voxels). Warped images were compared to target images using sum of absolute differences. Registration with APLDM was founded to lead to statistically significantly better results ($p<0.0002$) than without in case of large deformation (Tab 1). Vector field computed with APLDM lead to statistically significantly less negative Jacobian than without ($p < 0.001$). Warped images according to BH3-BH1 registration were also compared to the BH2 image and the relevance of the warped image was assessed by way of Jacobian-based studies. Even if warped images with and without APLDM seems to be visually comparable, deformation field (and thus voxel motion) were sensibly different (Fig 1). The two regularisations lead to comparable results.

Conclusions: This preliminarily model does not take into account motion hysteresis. However, simulation of 4D CT images from deformable registration of inhale and exhale CT image is feasible. The 4D model serves as a basis for 4D radiation therapy planning and simulation of 4D CT acquisitions. Future works will consist in comparing the model to acquired 4D-CT images.

	Lung volume increase	Initial SAD (before registration)	Gauss/without APLDM	Gauss/with APLDM	LE/without APLDM	LE/with APLDM
BH3-BH1	165%	231	66	51	62	47
BH2-BH1	152%	201	57	45	55	43
BH3-BH2	108%	89	26	25	25	24


Without APLDM
With APLDM