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Med Phys. 2017 Feb;44(2):762-771. doi: 10.1002/mp.12059. Epub 2017 Feb 2.

A longitudinal four-dimensional computed tomography and cone beam computed tomography dataset for image-guided radiation therapy research in lung cancer

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PMID: 27991677 PMCID: PMC5912888 DOI: 10.1002/mp.12059

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Abstract

Purpose: To describe in detail a dataset consisting of serial four-dimensional computed tomography (4DCT) and 4D cone beam CT (4DCBCT) images acquired during chemoradiotherapy of 20 locally advanced, nonsmall cell lung cancer patients we have collected at our institution and shared publicly with the research community.

Acquisition and validation methods: As part of an NCI-sponsored research study 82 4DCT and 507 4DCBCT images were acquired in a population of 20 locally advanced nonsmall cell lung cancer patients undergoing radiation therapy. All subjects underwent concurrent radiochemotherapy to a total dose of 59.4-70.2 Gy using daily 1.8 or 2 Gy fractions. Audio-visual biofeedback was used to minimize breathing irregularity during all fractions, including acquisition of all 4DCT and 4DCBCT acquisitions in all subjects. Target, organs at risk, and implanted fiducial markers were delineated by a physician in the 4DCT images. Image coordinate system origins between 4DCT and 4DCBCT were manipulated in such a way that the images can be used to simulate initial patient setup in the treatment position. 4DCT images were acquired on a 16-slice helical CT simulator with 10 breathing phases and 3 mm slice thickness during simulation. In 13 of the 20 subjects, 4DCTs were also acquired on the same scanner weekly during therapy. Every day, 4DCBCT images were acquired on a commercial onboard CBCT scanner. An optically tracked external surrogate was synchronized with CBCT acquisition so that each CBCT projection was time stamped with the surrogate respiratory signal through in-house software and hardware tools.

Approximately 2500 projections were acquired over a period of 8-10 minutes in half-fan mode with the half bow-tie filter. Using the external surrogate, the CBCT projections were sorted into 10 breathing phases and reconstructed with an in-house FDK reconstruction algorithm. Errors in respiration sorting, reconstruction, and acquisition were carefully identified and corrected.

Data format and usage notes: 4DCT and 4DCBCT images are available in DICOM format and structures through DICOM-RT RTSTRUCT format. All data are stored in the Cancer Imaging Archive (TCIA, <http://www.cancerimagingarchive.net/>) as collection 4D-Lung and are publicly available.

Discussion: Due to high temporal frequency sampling, redundant (4DCT and 4DCBCT) data at similar timepoints, oversampled 4DCBCT, and fiducial markers, this dataset can support studies in

锥形束CT

20名局部晚期非小细胞肺癌患者进行同步放化疗的序列4DCT和4DCBCT

放疗
RT + Chem. Drugs

marks in 4DCT

4DCT and 4DCBCT share the same coordinate

4DCT collects 10 phases

13/20 → 4DCT weekly

4DCBCT every

no mistakes

image-guided and image-guided adaptive radiotherapy, assessment of 4D voxel trajectory variability, and development and validation of new tools for image registration and motion management.

Keywords: 4D imaging; computed tomography; cone beam computed tomography lung.

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Figures

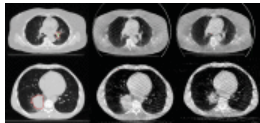


Figure 1 Example images from the dataset....

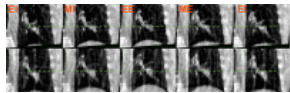


Figure 2 Example 4DCBCT phase images from...

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