(SD2021-430) Deep learning volumetric deformable registration: CNN-based Deformable Registration Facilitates Fast and Accurate Air Trapping Measurements at Inspiratory and Expiratory CT

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ABSTRACT

Researchers from UC San Diego developed a patent-pending convolutional neural network (CNN)-based deformable registration algorithm to reduce computation time for analysis of medical images such as CT and MRI.
These fast, fully-automated CNN-based lung deformable registration algorithms can facilitate translation of measurements into clinical practice, potentially improving the diagnosis and severity assessment of small airway diseases.

DESCRIPTION

CNN-based deformable registration algorithm performs automated co-registration of organs. Application of the algorithm to an input of lung CT image data provides accurate quantification of air trapping measurements in a broad cohort of patients with a wide range of pulmonary air trapping. The inventive approach reduces inference runtime, improves lobar overlap, and reduces voxel "folding."

Image registration is the process of identifying a spatial transformation that maps two (pair-wise registration) or more (group-wise registration) images to a common coordinate frame so that corresponding anatomical structures are optimally aligned. In other words, a voxel-wise "correspondence" needs to be established between the images. Automated co-registration is an essential feature of nearly all medical imaging applications, however, co-registration can be computationally expensive and particularly challenging for imaging of deformable organs, an extreme example of which is the lungs. The registration of inspirative and expirative lung CT images has important medical applications in the diagnosis and characterization of small airway disease and emphysema. Using accurate pulmonary registration, the local lung ventilation can be reliably quantified.

APPLICATIONS

Diseases affecting the small airways, such as chronic obstructive pulmonary disease (COPD),bronchiolitis obliterans related to stem cell transplantation or chronic lung allograft dysfunction, and cystic fibrosis, can manifest as pulmonary air trapping, which can go undetected on routine inspiratory chest CT. For each of these diseases, chronic inflammation and obstruction of the small airways limit the rate and volume of gas expulsion during expiratory phase, which is typically diagnosed via pulmonary function testing (PFT) through measurement of FEVl and FEVl/FVC.
Although air trapping may sometimes be observed as mosaic attenuation on expiratory phase CT, evidence has shown that diffuse air trapping can be difficult to detect visually. In contrast, quantitative measurements on a dedicated inspiratory/expiratory lung CT protocol can facilitate air trapping assessment, which has been shown to prognosticate both disease progression and mortality.

ADVANTAGES

CONTACT
Skip Cynar
scynar@ucsd.edu
tel: 858-822-2672.

OTHER INFORMATION

KEYWORDS
Air Trapping, Convolutional Neural Network, Deformable Registration, Small Airway Disease, CT, Lung, Semi-supervised Learning, Unsupervised Learning

CATEGORIZED AS
- **Imaging**
  - Medical
- **Medical**
  - Disease: Respiratory and Pulmonary System

RELATED CASES
2021-Z08-1

The inventive CNN-based deformable lung registration algorithm disclosed herein accurately quantifies air trapping measurements in a broad cohort of patients with a wide range of pulmonary air trapping, reduces inference runtime, improves lobar overlap, and reduces voxel "folding." Fast, fully-automated CNN-based lung deformable registration algorithms can facilitate translation of these measurements into clinical practice, potentially improving the diagnosis and severity assessment of small airway diseases.

STATE OF DEVELOPMENT

INTELLECTUAL PROPERTY INFO

UC San Diego is seeking companies interested in applying this patent-pending technology.

RELATED MATERIALS

- Hasenstab KA, Tabalon J, Yuan N, Retson T, Hsiao A. CNN-based Deformable Registration Facilitates Fast and Accurate Air Trapping Measurements at Inspiratory and Expiratory CT. Radiol Artif Intell. 2021 Nov 10;4(1):e210211. doi: 10.1148/ryai.2021210211. Erratum in: Radiol Artif Intell. 2022 Jan 12;4(1):e219003. - 11/10/2021

University of California, San Diego
Office of Innovation and Commercialization
9500 Gilman Drive, MC 0910, ,
La Jolla,CA 92093-0910

Tel: 858.534.5815
innovation@ucsd.edu
https://innovation.ucsd.edu
Fax: 858.534.7345