Multiple hypothesis tracking based extraction of airway trees from CT data
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MUltiple Hypothesis Tracking Based Extraction of Airway Trees from CT Data

Using statistical ranking of template-matched hypotheses

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Abstract
Segmentation of airway trees from CT scans of lungs has important clinical applications, in relation to the diagnosis of chronic obstructive pulmonary disease (COPD). Here we present a method based on multiple hypothesis tracking (MHT) and template matching, originally devised for vessel segmentation, to extract airway trees. Idealized tubular templates are constructed and ranked using scores assigned based on the image data. Several such regularly spaced hypotheses are used in constructing a hypothesis tree, which is then traversed to obtain improved segmentation results.

Introduction
COPD is a leading cause of mortality worldwide, characterised by:
- Destruction of the lung tissue (emphysema)
- Morphological changes to the airways

Existing methods:
- Airway tree segmentation is a challenging problem
- Most methods try to strike a balance between specificity and sensitivity
- Room for improvement on both fronts
- Single hypothesis / greedy algorithms
- Inconsistent decisions
- Only the best hypothesis is propagated
- Sensitive to noise
- Highly local solutions

MHT-based methods

Template matching-based MHT
Method based on [1], proposed for tracking small vessels.
- Designed to track small tubular structures
- Uses a scale-dependent score threshold
- Semi-automatic

Model
- Probability images obtained from trained KNN classifier (K = 21), airways (p = 1)
- Method in [1] is modified, while retaining the image model:
  \[ \text{image} = \text{contrast template} + \text{mean} + \text{noise} \]
- Template function (T) used to map probability variations to a profile function (P):
  \[ T(x,X_0,Y_0) = \frac{1}{(\sigma^2 k)} \exp \left( \frac{-(x-X_0)^2}{2 \sigma^2} + \frac{-(y-Y_0)^2}{2 \sigma^2} \right) \]

MHT allows for improved tracking decisions, as tracking solutions are not local.
Method in [1] has been modified to extract airway trees.

References