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. Individual 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

Objective:
Develop segmentation methods, with improved specificity and sensitivity, to study morphological changes of airway trees in COPD. Here we present a method based on multiple hypothesis tracking.

Abstract

Image data is used to update the guesses and ranked using scores assigned based on the image data. Several such regularly spaced hypotheses are maintained.

MHT-based methods

MHT and ranking based MHT methods

Idea: Defeasible decision at current step to a future step. Meanwhile, maintain all hypotheses.

Multiple hypothesis tracking (MHT)

Philosophy: Delay decisions. Use more data. Benefit from hindsight.

• Widely used in multi-target tracking [5]
• Deferred decision based on more data
• Several hypotheses are maintained
• Search depth controls the size of tree
• Trade-off between optimality, tractability

A tracking perspective to segmentation

• Prediction by regularly spaced guesses
• Image data is used to update the guesses

Results

• Set of 32 images split into training, test sets
• Danish Lung Cancer Screening Trial data used [2]

Error distance:

\[ d_{ij} = \sum_{c=1}^{n} \min (d_{ij,c} - d_{op,c}) \]

Dc refers to the centerlines of reference, output and hypothesis.

Conclusions

• MHT allows for improved tracking decisions, as tracking solutions are not local.
• Method in [1] has been modified to extract airway trees.
• Ranking based scheme is more suitable for extracting airways, where structures of varying dimensions are observed.

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References


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