Identification of paediatric tuberculosis from airway shape features
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Introduction
- Prevalence of TB is still high, particularly in developing countries
- Poor detection rates in children
- Primary TB in children is characterised by lymphadenopathy
  leading to displacement and stenosis of airway branches

Aim:
- Assist in the detection of TB from airway shape
- Segment and model airway shape changes from CT scans

Method
Airway Segmentation
- Detect trachea
- 3D morphological closing and reconstruction
- Seeded region growing

Skeletonisation and branch point detection
- Iterative topology preserving thinning
- Branch point detection by voxel connectivity

Airway Correspondence
- Equidistant sampling of centreline
- Projection of points onto surface orthogonal to centreline
- Surface points used as landmark points for TPS warp

Dataset
- 61 Patients
- TB and non-TB
- Mean 33 months
- Min 2 months
- CT Scan
  - Axial plane 0.3-0.5mm
  - Slice thickness 0.7-1mm

Local Alignment
- Local alignment of surface required after TPS
- Forcing function directs alignment
- Expansion/contraction force improves matching with stenosed branches

\[ F_{i,1} = \mathbf{f}_i - \mathbf{e}_i \]
\[ F_{i,2} = \sum_j (\mathbf{v}_j ||\mathbf{v}_j|| - ||\mathbf{v}_j||) \quad \text{where} \quad \mathbf{v}_j = \mathbf{f}_i - \mathbf{e}_i \]
\[ F_{i,3} = \alpha F_{i,1} + \beta F_{i,2} + \gamma F_{i,3} \]

Thin plate spline warp
- Warp vertices onto a template airway to generate matching vertices
- Landmark points direct warp by minimisation of bending energy
- ~1500 vertices

Conclusions
- Both PCA based features and branch features accurately distinguish between TB and non-TB cases
- This method shows the potential of airway shape analysis to assist in the detection of airway pathology
- Future work:
  - Test method on a larger dataset
  - Local analysis of pathology

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