**A Framework for Medical-Imaging-Fragment Based Whole Body Atlas (WBA) Construction**

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**Introduction and Motivation**

The thesis proposes a method for the construction of an atlas from multiple medical imaging fragments that show different parts of the body. The method first builds an initial atlas based on a small number of whole body CTs. Then the final atlas is constructed by registering a large number of fragments, and at the same time minimizing the bias.

To illustrate the information encoded in the atlas, population analysis in the atlas space is performed, and correctly identifies plausible sub-populations.

**Atlas Point of View**

Human anatomy exhibits variability:
- Sizes or shapes of organs
- Physiological state
- Disease characteristics

Anatomical atlas construction overcomes this variability.

**Based on images containing identical anatomical structures!**

Example: Brain NMI Atlas

**Data Point of View**

Hospitals produce hundreds of GBs of pathology driven medical imaging data every day.
- Distributed across the entire body
- Holds diagnostic information

→ Precondition for existing atlases is not fulfilled!

**Medical Imaging Data**

**Methodology**

**Initial Least Biased Whole Body (WB) Reference Selection**

**Methods**
- MDS Embedding Space Center
- Registration Cost Minimization
- Geodesic Center Estimation

**Fragment Center Estimation**

**Input Fragment**  
**Similarity with Annotated Miniature Set**  
Robust Center Estimation based on k Most Similar Miniatures

**Fragment Region Estimation and Non-rigid Registration**

**Input Fragment**  
**Registration of Corresponding Fragment Regions**

**Fragment Based WBA Construction**

**Average Fragment Registration**

\[ V = \frac{1}{N} \sum_{i=1}^{N} T_{F_i,R}(F_i) \]

**Average Deformation**

\[ T = \frac{1}{N} \sum_{i=1}^{N} T_{F_i,R} \]

**Draw Average Registration towards Population Center**

\[ R_F = T^{-1}(V) \]

**Fragment Based Population Analysis**

**Features**
- Overlap
- Deformation Similarity
- Registration Costs

**Affinity Data**

- Spectral Clustering
- Iso-Map Clustering

**Results**

**Fragment Based WBA Construction**

**Initial WB Reference R**  
**Fragment Based WBA R_F**

**Distance of Landmark Distributions to Centroids (Abdomen)**

**Exploratory Population Analysis**

**Detection of Biological Plausible Sub-Populations**

(\*female vs. \*male)

**Conclusion**

We propose an anatomical atlas framework providing:

An iterative algorithm for fragment to WB reference space registration.

Methods for medical-imaging-fragment based computation of representative population atlases.

Methodology for fragment based sub-population analysis.

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