FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Master's Thesis Presentation

CVL Computer Vision Lab

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

Master's Degree:
Medical Informatics

Matthias Dorfer

Vienna University of Technology
Institute of Computer Aided Automation
Computer Vision Lab
Supervisor: Ao.Univ.-Prof. Dr. techn. Robert Sablatnig
Co- Supervisor: Ass.Prof. Dipl.-Ing. Dr. Georg Langs

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!

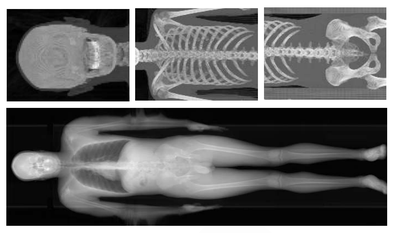
Example:
Brain MNI Atlas

Data Point of View

Hospitals produce hundreds of GBs of pathology driven medical imaging data every day.

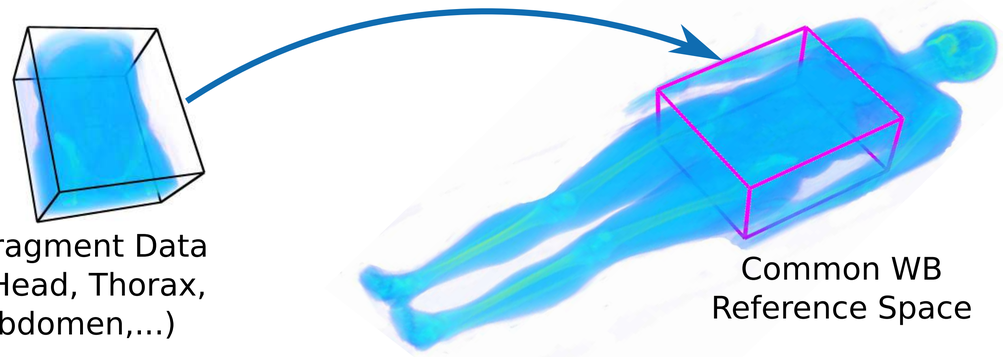
- Distributed across the entire body
- Holds diagnostic information

→ Precondition for existing atlases is not fulfilled!



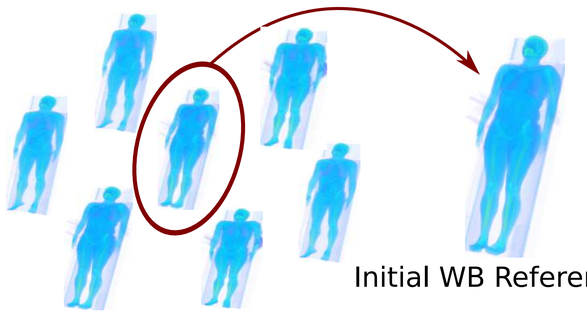
Medical Imaging Data

To use large scale clinical data a method for medical imaging fragment based anatomical atlas constriction is necessary.



Methodology

Initial Least Biased Whole Body (WB) Reference Selection



Methods

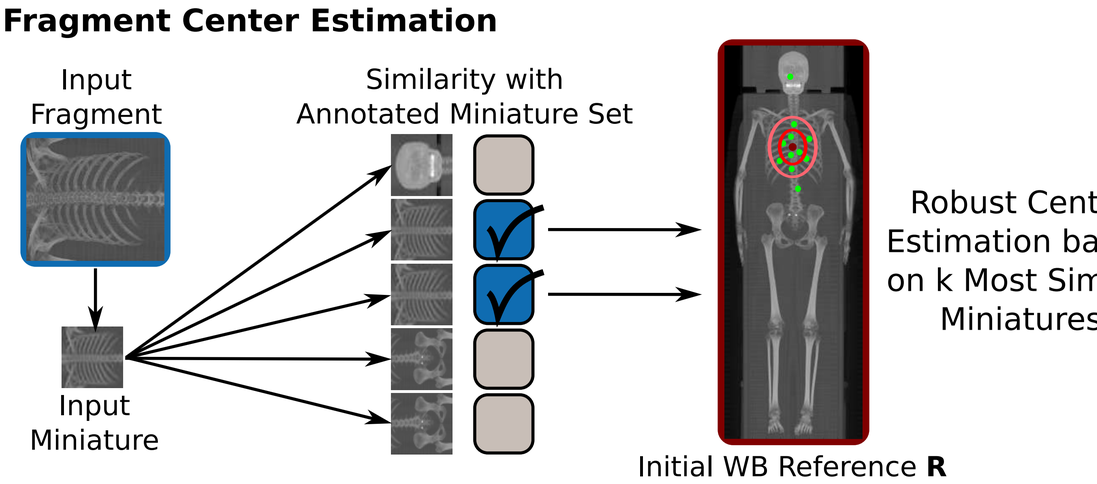
MDS Embedding Space Center

Registration Cost Minimization

Geodesic Center Estimation

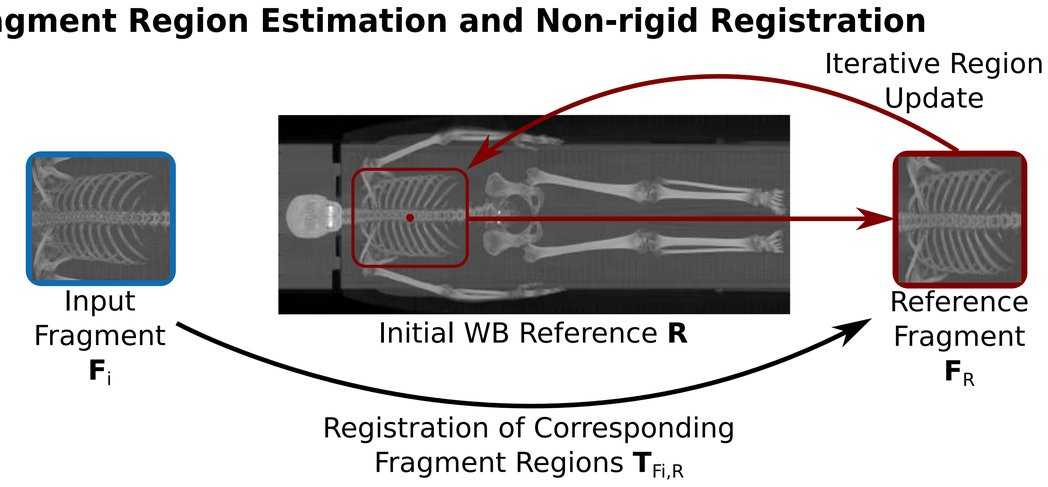
Initial WB Reference **R**

Fragment Center Estimation



Robust Center Estimation based on k Most Similar Miniatures

Fragment Region Estimation and Non-rigid Registration



Fragment Based WBA Construction

Average Fragment Registration

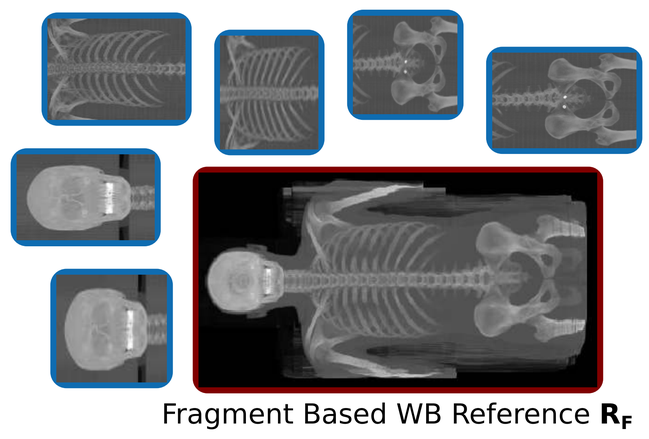
$$\overline{\mathbf{V}} = \frac{1}{\mathbf{N}} \sum_{i=1}^{N} \mathbf{T}_{\mathbf{F}_i,\mathbf{R}}(\mathbf{F_i})$$

Average Deformation

$$\overline{\mathbf{T}} = \frac{1}{\mathbf{N}} \sum_{i=1}^{N} \mathbf{T}_{\mathbf{F}_i,\mathbf{R}}$$

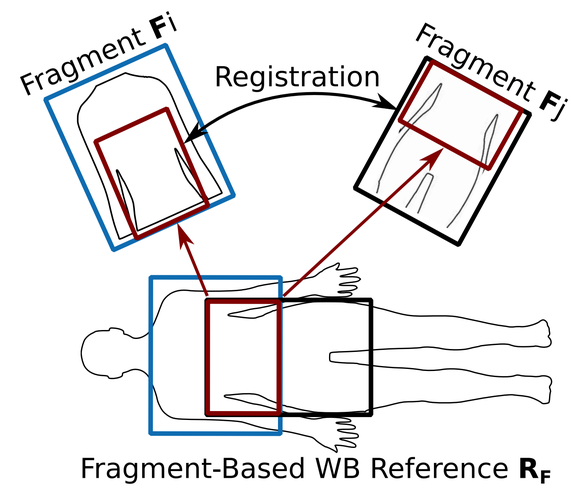
Draw Average Registration towards Population Center

$$\mathbf{R_F} = \overline{\mathbf{T}}^{-1}(\overline{\mathbf{V}})$$



Fragment Based WB Reference $\mathbf{R_F}$

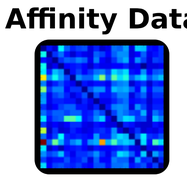
Fragment Based Population Analysis



Fragment-Based WB Reference $\mathbf{R_F}$

Features
- Overlap
- Deformation Similarity
- Registration Costs

Affinity Data

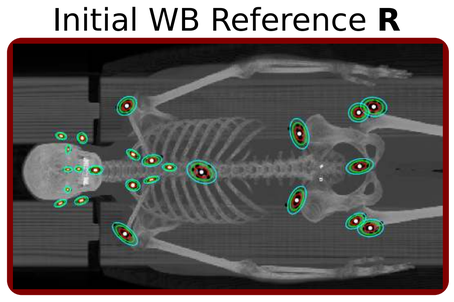


Similarity Analysis
- Spectral Clustering
- Iso-Map Clustering

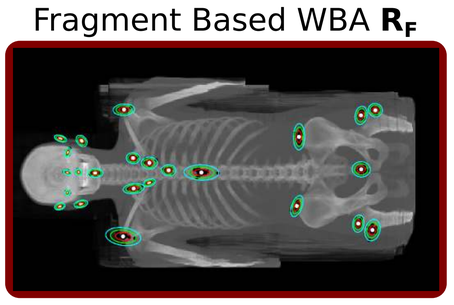
Results

Fragment Based WBA Construction

Initial WB Reference **R**

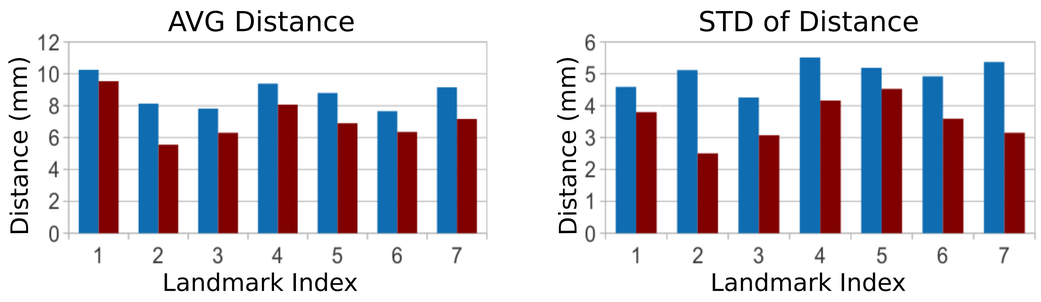


Fragment Based WBA $\mathbf{R_F}$

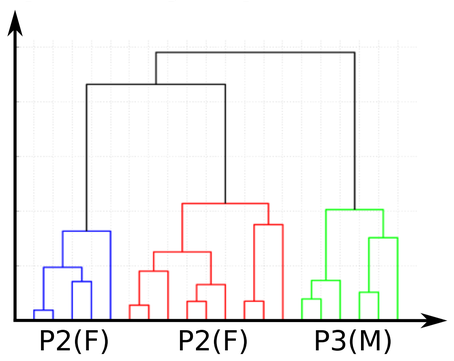


Landmark Transformation Accuracy

Distance of Landmark Distributions to Centroids (Abdomen)



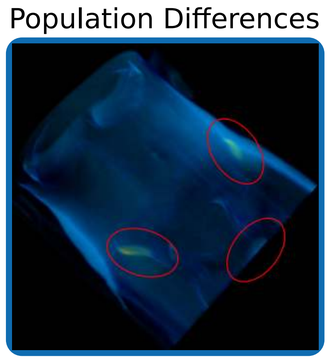
Exploratory Population Analysis



Detection of Biological Plausible Sub-Populations

(F)emale vs. (M)ale

Population Differences



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.

Contact: matthias.dorfer@gmx.at