Lumen Segmentation of Cerebral Vasculature in Three-dimensional C-arm Angiography Images

Master's Thesis Introductory Talk

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# Clinical Background

Digital Subtraction Angiography (DSA)

- Imaging method based on radiation (X-ray)
- Radiologists inject contrast agent into blood vessels of patient
- Subtraction of image prior to and after contrast agent injection

- Third dimension obtained using Computed Tomography principle

- Useful to detect e.g. brain tumor, atherosclerosis and aneurysms

Brain Arteries
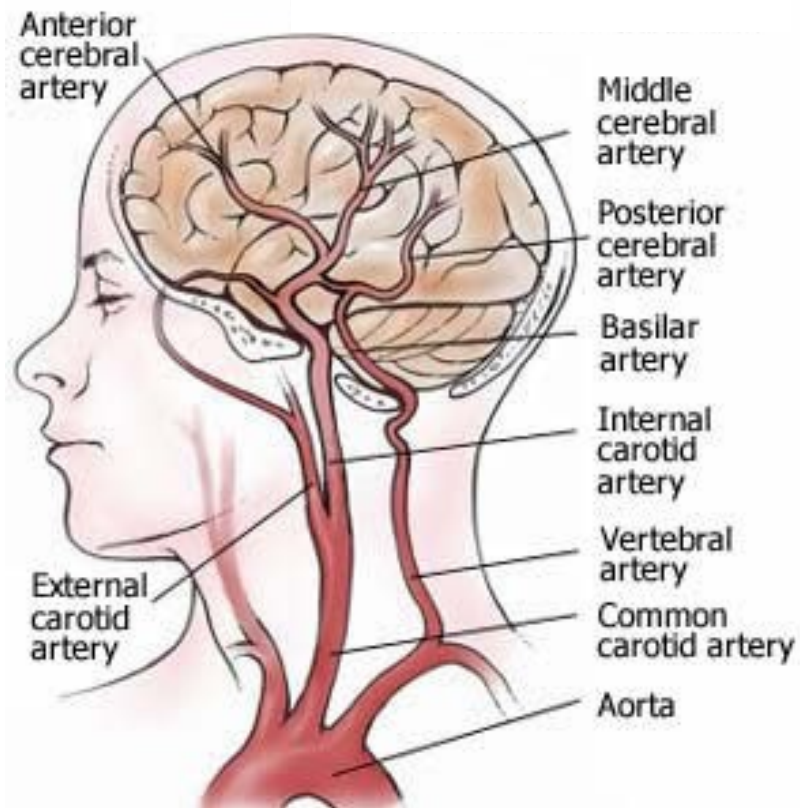
Cerebrovascular System
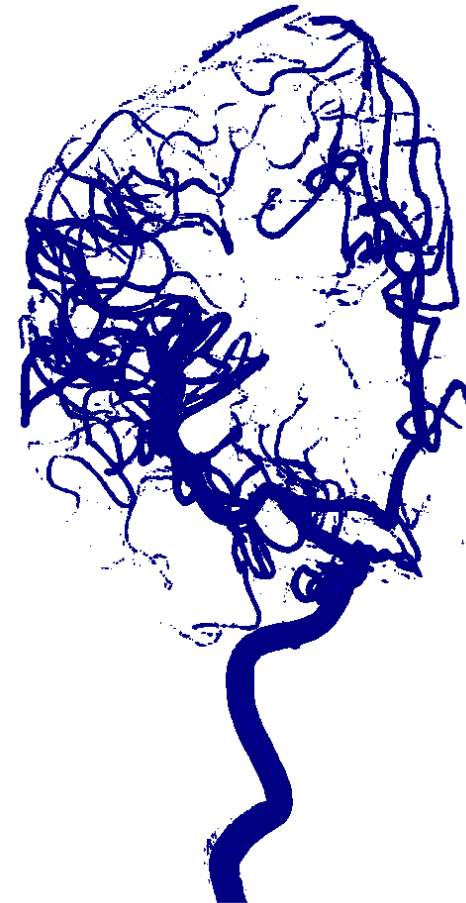
Vessels of example dataset

Segmentation

Vessel Segmentation Methods

- Region growing

- Active Contours

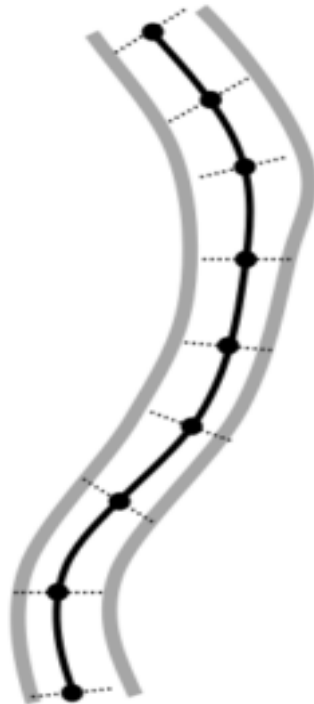- Centerline based

- Stochastic frameworks
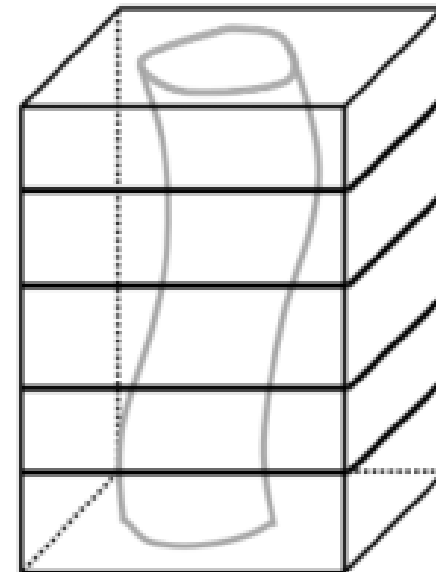
Our Segmentation Approach

- Based on F. Lugauers approach which was applied on coronar arteries

- Centerline based
- Machine learning based decision
- Uses ray casting in combination with Markov Random Fields (MRF)

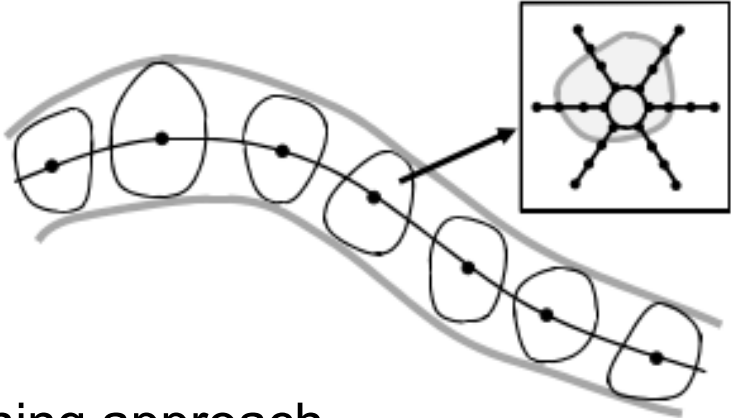# Our Segmentation Approach: Preprocessing

Step 1: Centerline extraction   Step 2: Volume warping

Our Segmentation Approach: Boundary Detection

- Step 3: Boundary map generation
  - Ray-casting (1-D search in polar coord.)

- Step 4: Decision based on machine learning approach
  - Feature vector **x** calculated out of local intensities and gradient-based features at a certain position p
  - Training by manually segmented datasets
  - Classifier: Probabilistic boosting tree or random forest
  - After training classifier can predict boundary probability for each feature vector **x** at position p

Our Segmentation Approach: Segmentation

- Step 5: Graph construction
  - Reformulate segmentation as network graph problem:
    transform boundary map into a MRF
  - Assign neighborhood dependencies for smoothness

- Step 6: Contour extraction from the partitioned graph
  - Select best suiting boundary by max-flow-min-cut algorithm

Our Segmentation Approach: Evaluation

- Manual segmented datasets (= gold standard)

- Comparison to at least one other approach (e.g. threshold based)

Goals

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- Reliable and fast segmentation

- To be used e.g. for diameter calculation of flow computation

Summary

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- 3-D DSA datasets used

- 3 major steps
    - Preprocessing (centerline)
    - Boundary detection (machine learning)
    - Segmentation (graph construction)

Thank you for your attention!