

Extraction of Vessels from Angiograms

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Introduction

Applications

- Initial step for feature-based algorithms
 - Intra-operative guidance
 - Reconstruction of coronary arteries

Objective of the IDP

- Segmentation of coronary arteries
- Implementing different algorithms in the ITK framework
- Testing and comparing the algorithms



Introduction

Data

- (Rotational) angiography sequences from stationary C-arms
- Contrasted coronary arteries
- No radial distortion
- Pixel spacing is $0.3 \times 0.3\text{mm}$ or $0.6 \times 0.6\text{mm}$

Problems

- Projection images
→ Overlay of vessels and other structures
- Varying contrast
- Decreasing vessel width



Methods

Segmentation Algorithms

- Multiscale vessel enhancement filtering – (Frangi, 1998)
- Multiscale detection of curvilinear structures in 2-D and 3-D image data – (Koller, 1995)
- Vessel segmentation using a shape driven flow – (Nain, 2004)

Improve the images with image processing algorithms

Segmentation

- Assumption of a linear structure of the vessels
- Eigen value analysis of the image intensities of every pixel
- Analyzing with different scales (scale space)

Methods

Frangi

- One of the standard papers on Hessian-based vessel filtering
- Basis for many other papers w.r.t
 - Usage of the Hessian
 - Multiscale analysis for vessels

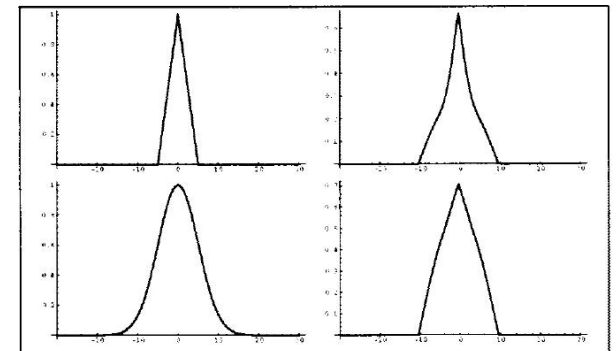
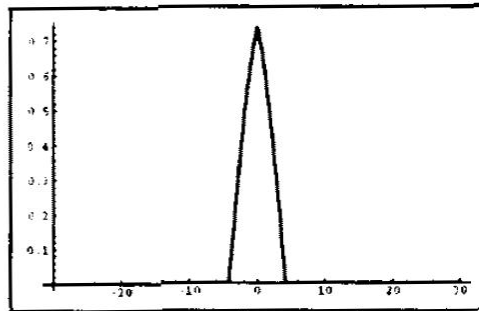
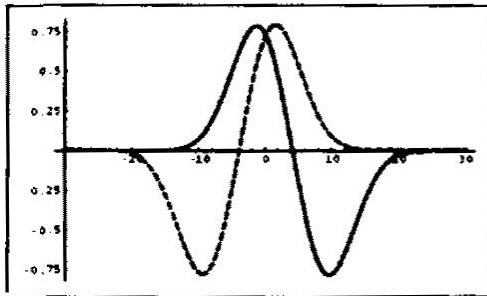
Frangi, Niessen, Vincken, and Viergever. Multiscale vessel enhancement filtering. MICCAI, vol. 1496 of LNCS, pp. 130-137. Springer, 1998



Methods

Koller

- Detect curvilinear structures of arbitrary shape
- Using the 2nd derivation of the Gauß-Function to resolve the edges left and right of the vessel-profile
- Non linear algorithm => using positive min-function
- Multiscale analysis
- User input min. and max. of the vessels width



Koller, Gerig, Székely, and Dettwiler. Multiscale detection of curvilinear structures in 2-D and 3-D image data. ICCV, pp. 864-869, 1995

Methods

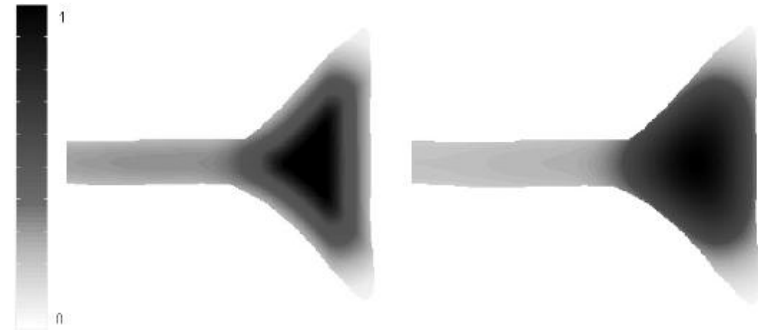
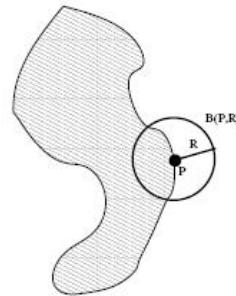


Nain

- Region based flow deforms the curve of interest
- Using level set techniques to evolve the active contour
- Determine the shape of a contour with a local ball filter (values between 0-1)
- small near-circle evolution
- User input: Max. vessel width

$$E(C) = - \int_R \phi d\mathbf{x} + \int_C ds + \alpha \int_R \epsilon_1^p(\mathbf{x}) d\mathbf{x}$$

$$\frac{\partial C(\mathbf{x})}{\partial t} = \left(-\phi(\mathbf{x}) + \kappa + \alpha \epsilon_2(\mathbf{x}, p) \right) \mathcal{N}$$



Nain, Yezzi, and Turk. Vessel segmentation using a shape driven flow. MICCAI, vol. 3216 of LNCS, pp. 51-59. Springer, 2004

Objectives

- Quantitative comparison of results
- Manually segmented data as “ground truth”
- Investigating improvements through specializing algorithms to coronary angiography

