

Tracking & Reconstruction of Guide Wires in Interventional Radiology

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Introduction

Tracking and reconstruction of guide wires are closely involved with some minimally invasive medical procedures like cardiac- and neuro-interventions. During these procedures, guide wires are navigated through the patient's vessel system under X-ray guidance. Our goal is to derive and evaluate techniques that can track the guide wires in 2D fluoroscopic images and then reconstruct the information in 3D to assist the doctors during the interventions.

Methods

2D guide wire tracking

A third order B-spline curve parameterization is used to represent the guide wire:

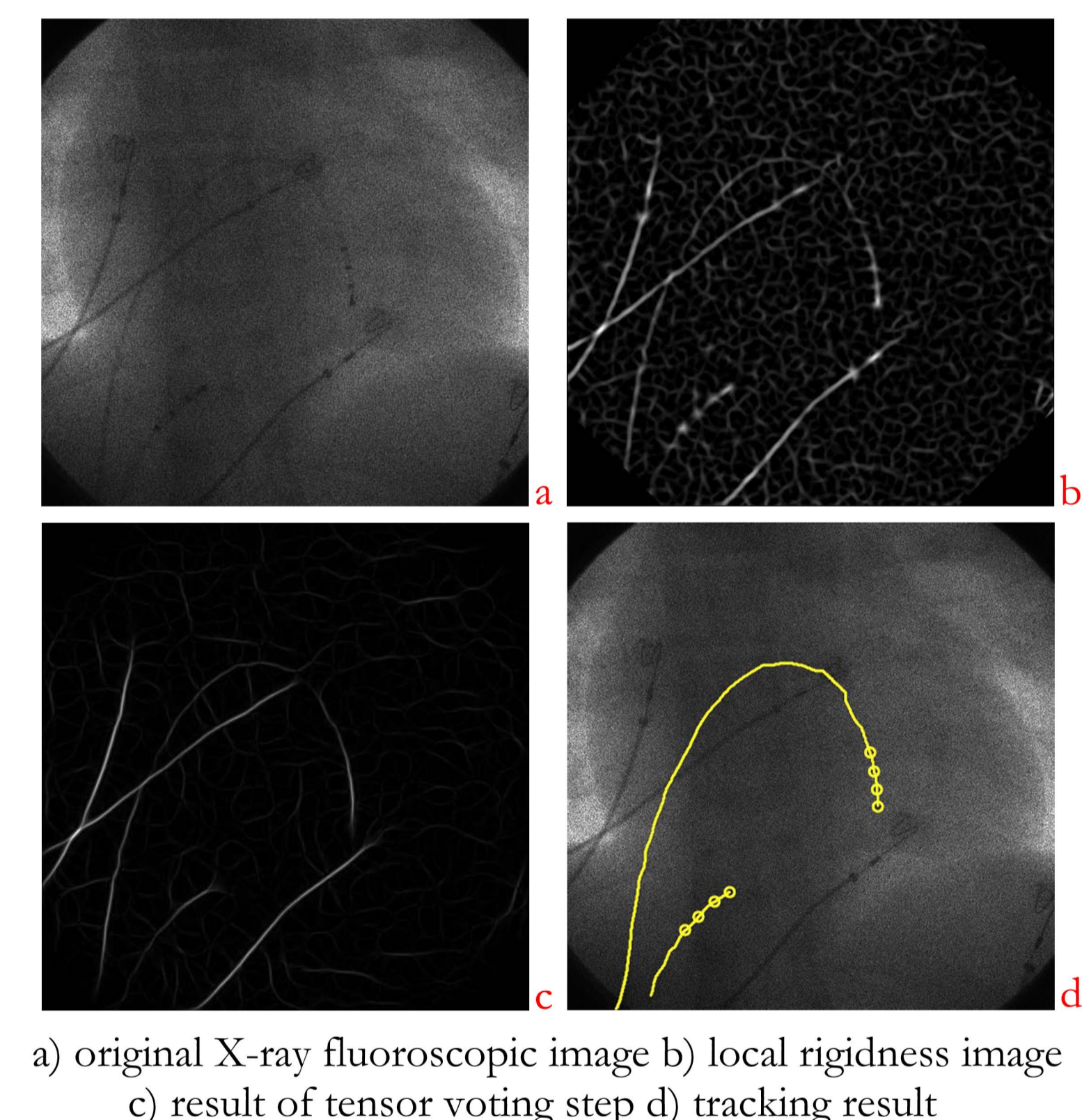
$$C(u) = \sum_{j=0}^P N_{j,3}(u) P_j \quad 0 \leq u \leq 1$$

1) Ridge detection (low SNR inherent to X-ray fluoroscopy):

(i) Hessian-based detectors (e.g. Vesselness); (ii) Tensor Voting; (iii) Steerable filters.

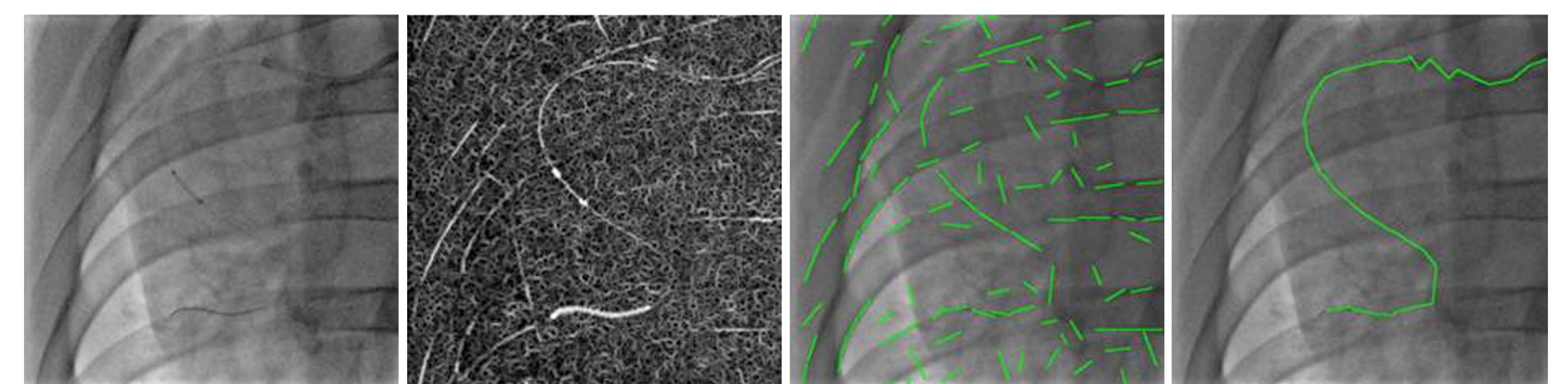
2) Construction of deformation models:

- Represent guide-wire with a third order B-Spline parameterization.
- Energy functional (data term, curvature, prior knowledge, etc.).
- Optimization: (i) Gradient descent algorithms (Continuous domain); (ii) Dynamic programming or MRFs.



Machine learning based guide wire tracking:

- 1) In low-level, Boosting is applied to search short line segments: Probabilistic Boosting Tree (PBT);
- 2) In middle-level, grouping & ordering: Cascade classifiers to achieve n-segment curves (Perceptual organization of segments);
- 3) In high-level, fitting a B-spline approximation to the ordered segments.



3D guide wire reconstruction

3D guide wire reconstruction from biplane image sequences and tracking for navigation (Calibration; Spline positioning):

- 1) 3D Guide wire reconstruction from biplane image sequences for integrated display in 3D vasculature TMI, vol. 22, no. 10, 2003.
- 2) 3D Guide wire tracking for navigation in endovascular interventions, SPIE, vol. 5367, 2004.

