Medical Image Processing for Interventional Applications

Teaser – Course Introduction

Online Course – Unit 1

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Overview

- Image preprocessing and image enhancement
- Image information extraction
- Non-rigid image registration
- Interventional reconstruction

Mathematical Tools

The lecture will emphasize on various mathematical tools:

- linear algebra,
- discrete differentiation,
- local and global optimization,
- variational calculus,
- partial differential equations.

Image Preprocessing

- Edge detection
- Hough transform
- Structure tensor
- Vesselness filter

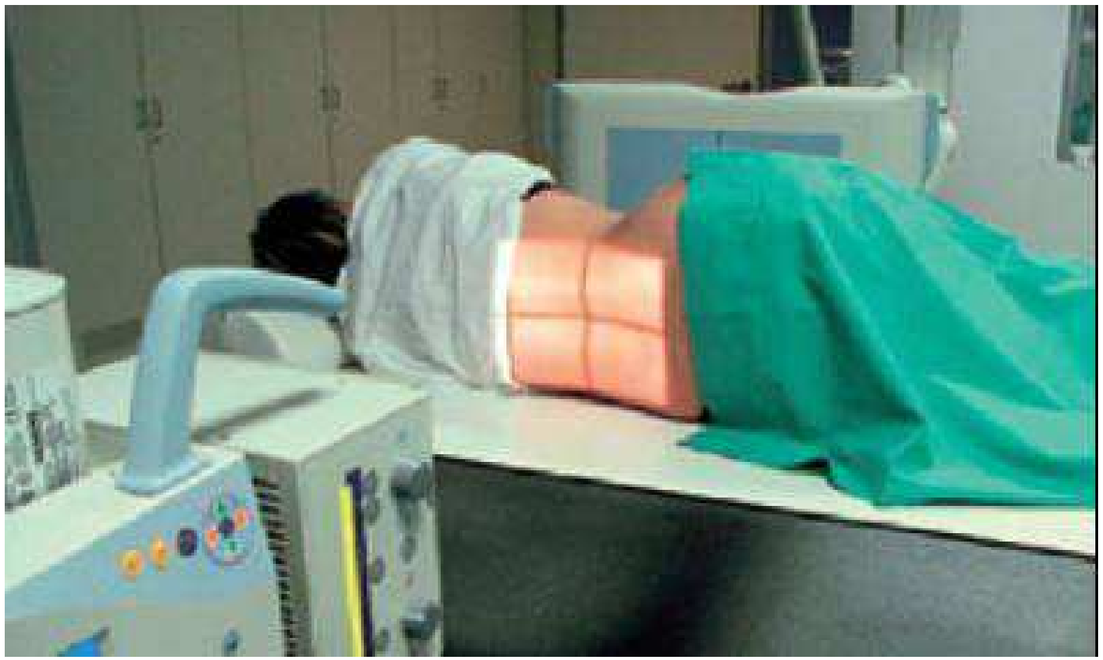
Image Enhancement

- Linear filtering
- Joint bilateral filtering
- Guided filter
- Super resolution

Image Information Extraction

- Epipolar geometry and consistency
- Structure from motion (factorization)
- Localization of organs
- Segmentation of cysts in kidneys using random walk algorithm
- Active shape models

Shutter Correction



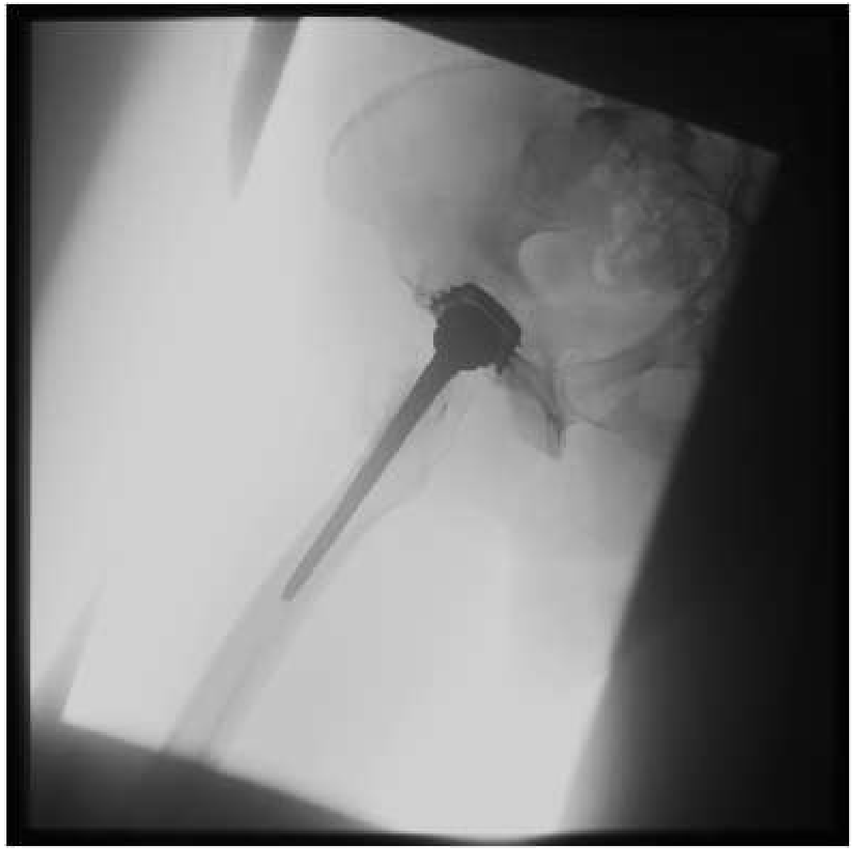


Figure 1: Shutter – detection of boundaries required

Example Images: Shutter Detection

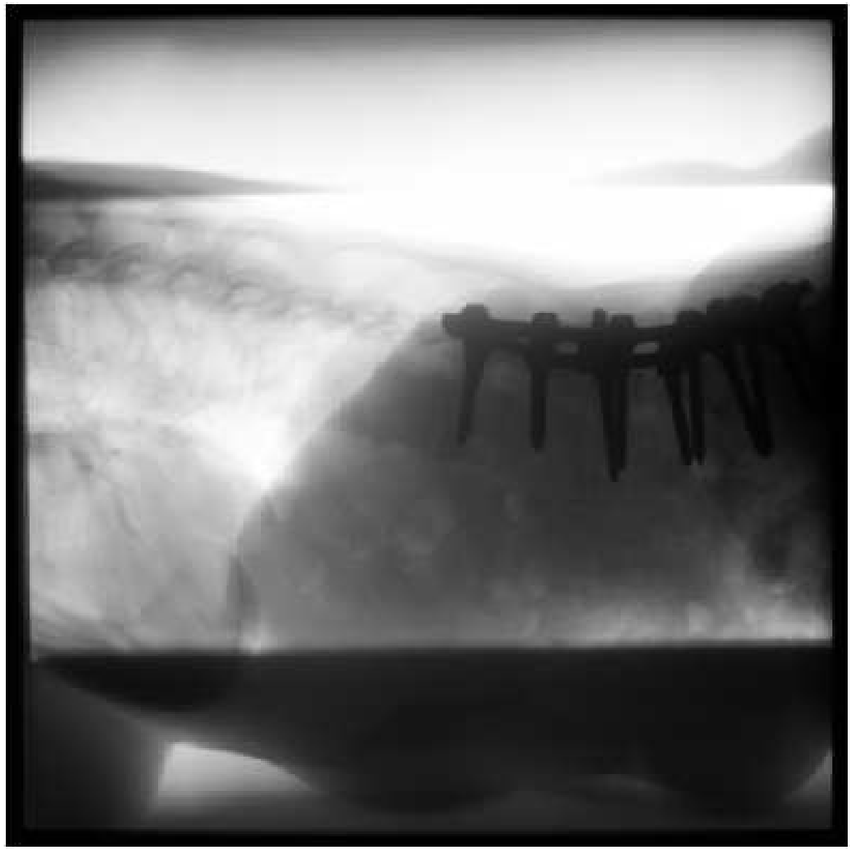


Figure 2: Shutter – detection of boundaries required

Example Images: Shutter Detection

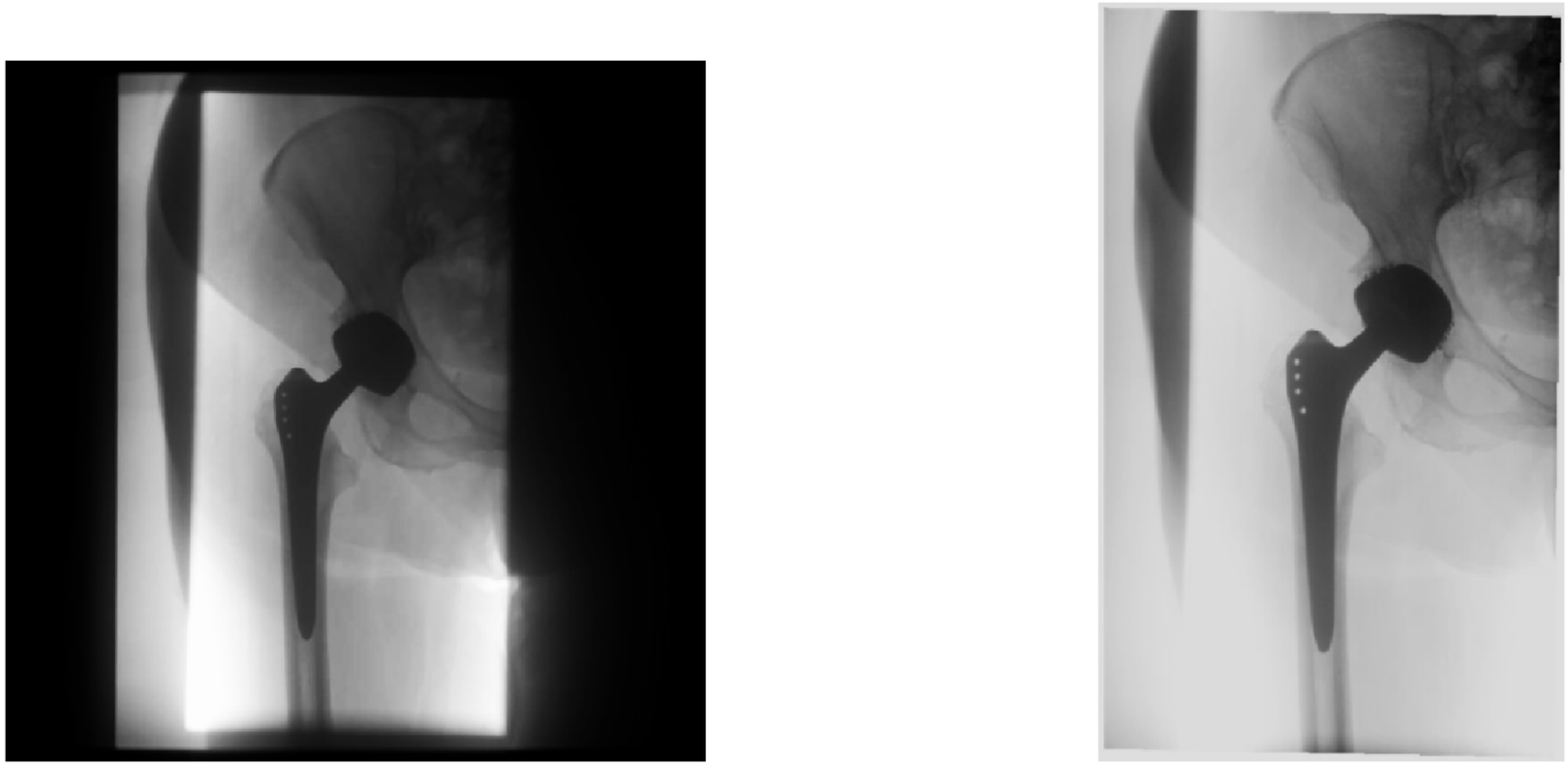


Figure 3: Example for shutter detection (Klaus Finkler, Siemens Healthcare)

Computer Guided Intervention and Surgery

- Magnetic catheter navigation
- Augmented reality in minimal invasive surgery
- NOTES: **N**on **o**bstructive **t**ransluminal **e**ndoscopic **s**urgery

Figure 4: Magnetic navigation (image courtesy of Siemens Healthcare)

Computer Guided Intervention and Surgery

Figure 5: Brainlab navigation system

Non-Rigid Image Registration

- Digital subtraction imaging
- Non-rigid mono-modal image registration (variational approach)
- Non-rigid image registration using geometric constraints
- Non-rigid image registration using prior knowledge

Interventional Reconstruction

- 3-D ultrasound reconstruction
- Motion compensated reconstruction:
  - ECG gating
  - Motion compensated reconstruction using deformation
  - ECG guided motion detection

What makes Medical Image Processing for Interventional Applications so special?

- Hands-on-hardware lecture
- Insight into research results from important scientific publications
- Topics of high interest for industry projects
- Excellent preparation for bachelor's or master's thesis projects
- **Difficult, but tons of fun!**