Medical Image Processing for Interventional Applications

Feature Matching – Applications in Medical Image Processing

Online Course – Unit 14

Andreas Maier, Sebastian Bauer, Frank Schebesch
Pattern Recognition Lab (CS 5)

virtuelle hochschule bayern

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TECHNISCHE FAKULTÄT

Topics

Applications in Medical Image Processing

Summary

Take Home Message

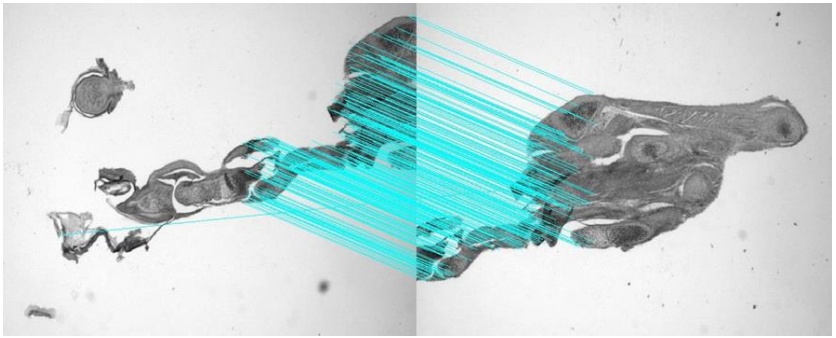
Further Readings

Examples

- Microscopic imaging: image alignment, stitching
- Augmented reality in open liver surgery: registration of intra-operative with pre-operative data
- Patient positioning in radiation therapy: pose/transformation estimation

Microscopic Imaging

- Image registration
- Stitching



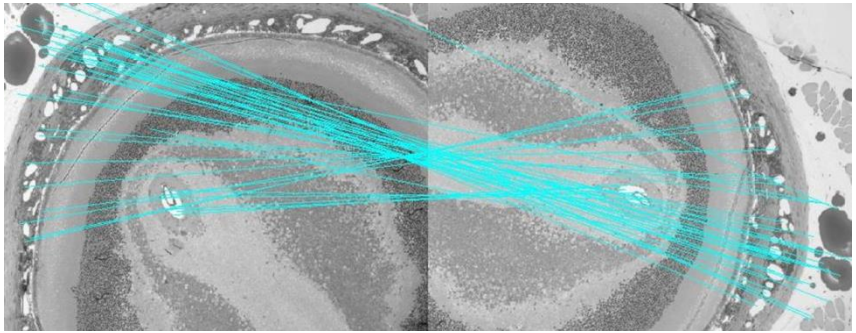


Figure 1: Images by S. Gaffling, Pattern Recognition Lab, FAU

Augmented Reality in Open Liver Surgery (cf. Beller et al., 2007)

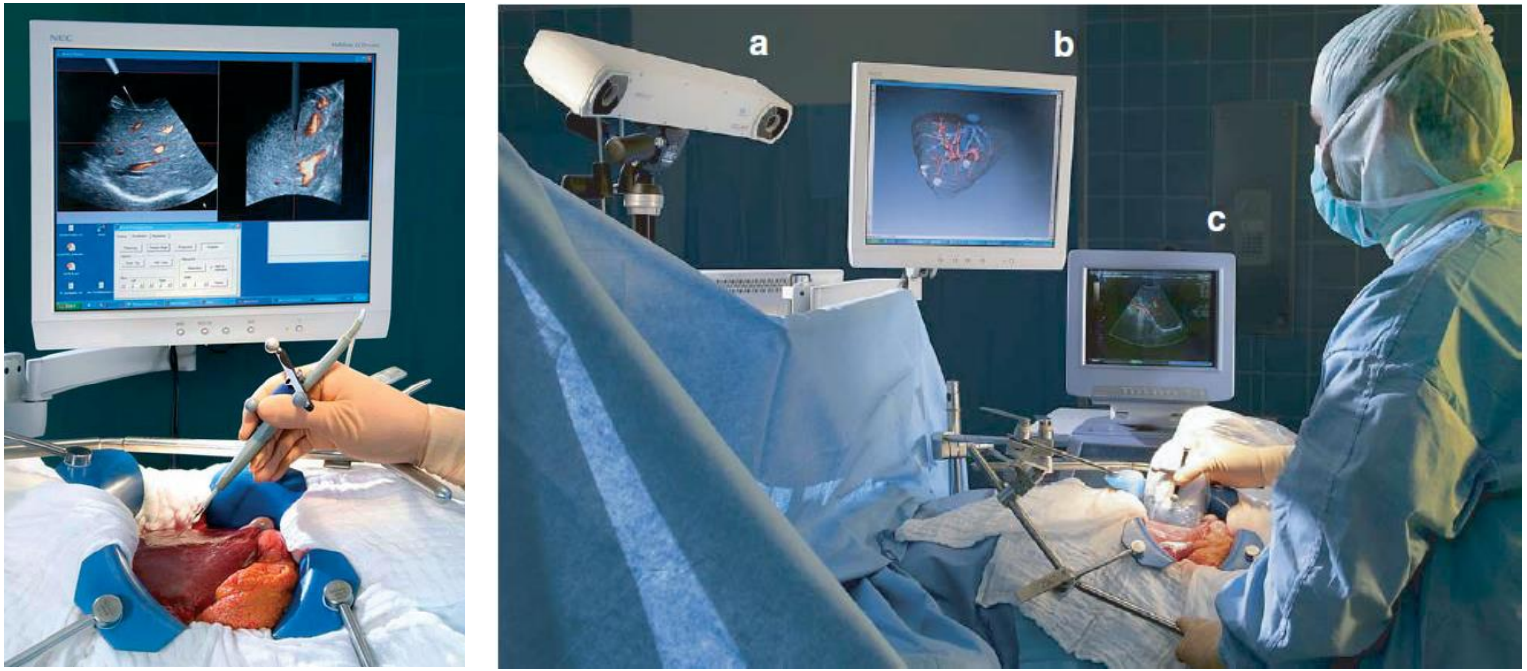


Figure 2: Organ registration – range imaging / CT

Augmented Reality

Liver registration: range imaging / CT

- From 2-D to 3-D surface features
- Same matching pipeline

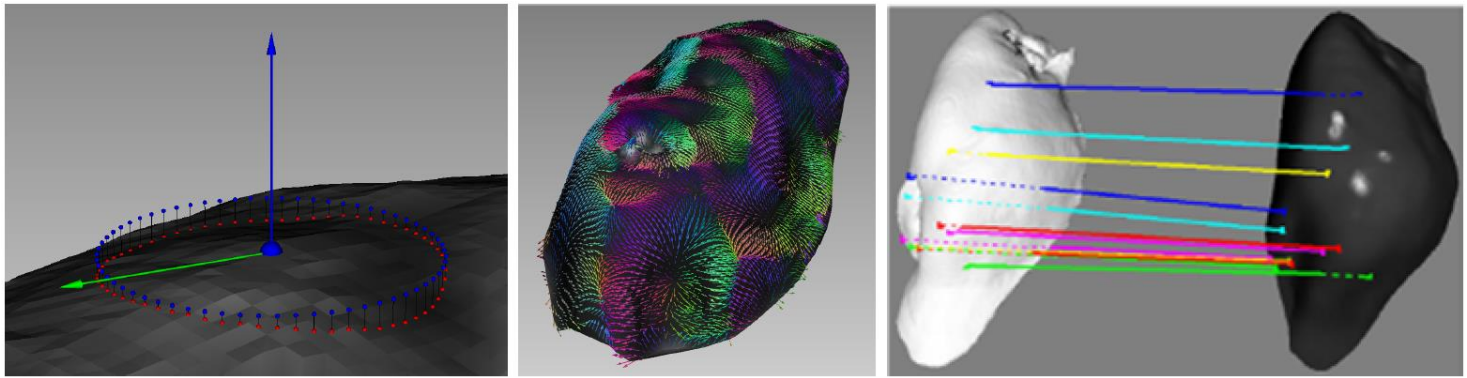


Figure 3-1: Images by S. Bauer and J. Wasza, Pattern Recognition Lab, FAU

Augmented Reality

Liver registration: range imaging / CT

- From 2-D to 3-D surface features
- Same matching pipeline

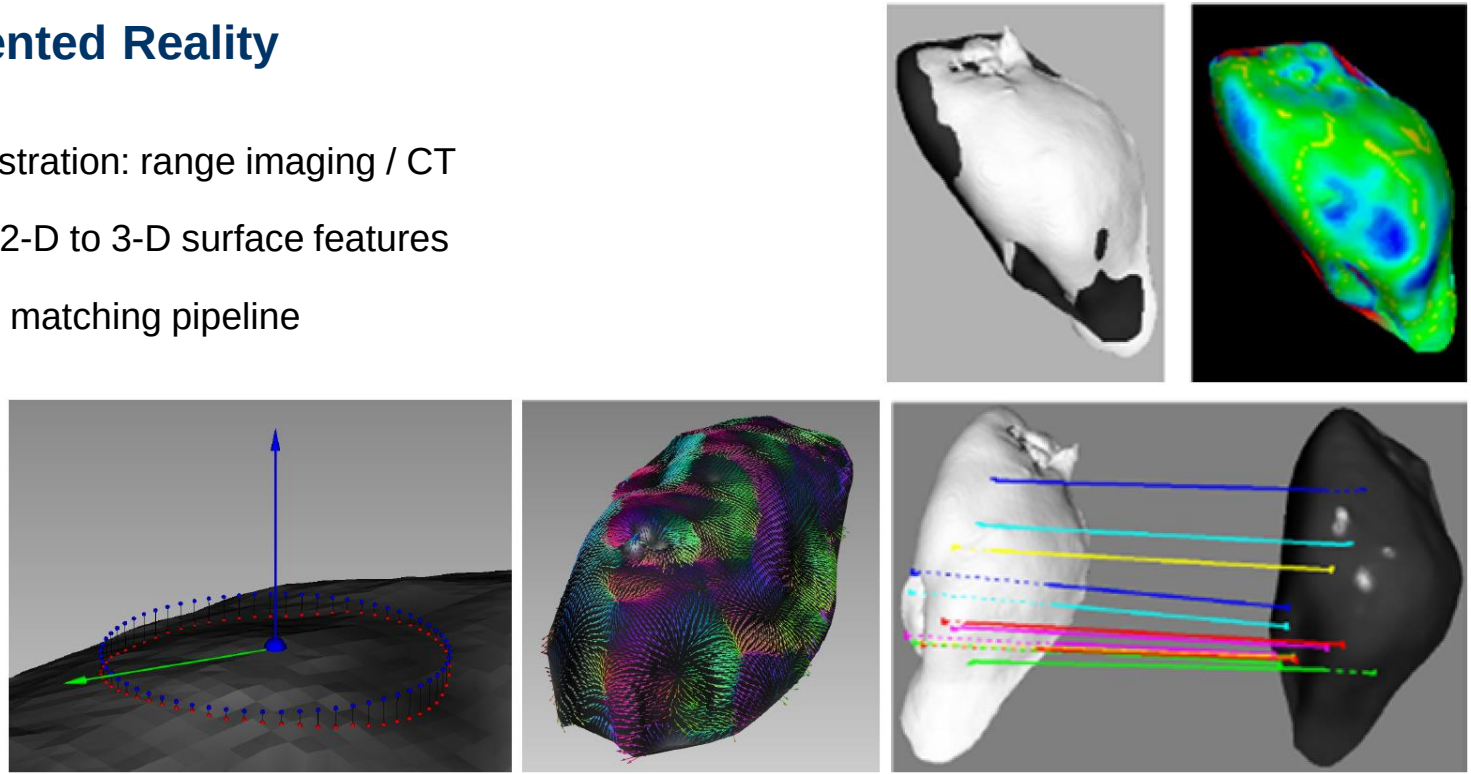


Figure 3-2: Images by S. Bauer and J. Wasza, Pattern Recognition Lab, FAU

3-D Local Invariant Feature Descriptors

- Spin images
- MeshHOG
- RIFF
- …

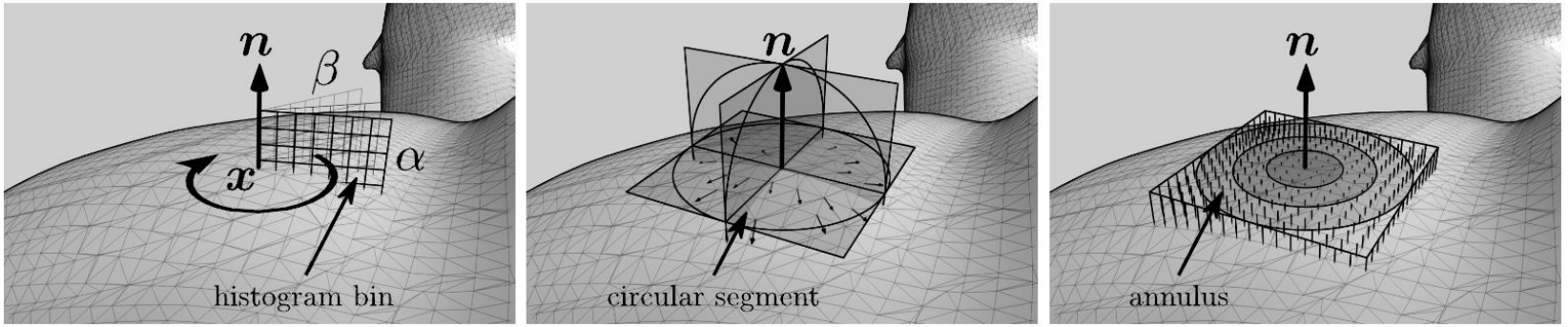


Figure 4: Images by S. Bauer, J. Wasza, and S. Haase, Pattern Recognition Lab, FAU

Spin Images (cf. Johnson and Hebert, 1999)

- Express neighborhood in 2-D cylindrical coordinates:

$$\alpha = \boldsymbol{n}^T(\boldsymbol{v} - \boldsymbol{x})$$
$$\beta = \sqrt{\|\boldsymbol{v} - \boldsymbol{x}\|_2^2 - \alpha^2}$$

  - α signed elevation component
  - β perpendicular radial distance

- Descriptor: 2-D histogram over the (α, β) space

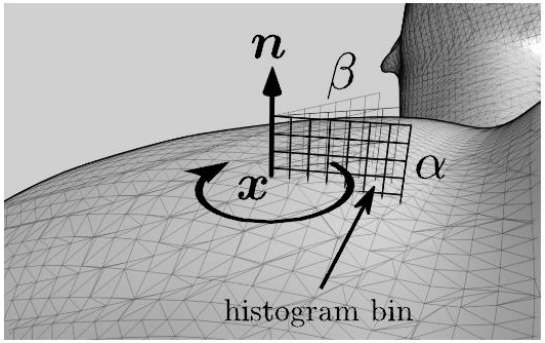


Figure 5: Image by S. Bauer, J. Wasza, and S. Haase, Pattern Recognition Lab, FAU

3-D Range Imaging in Radiation Therapy

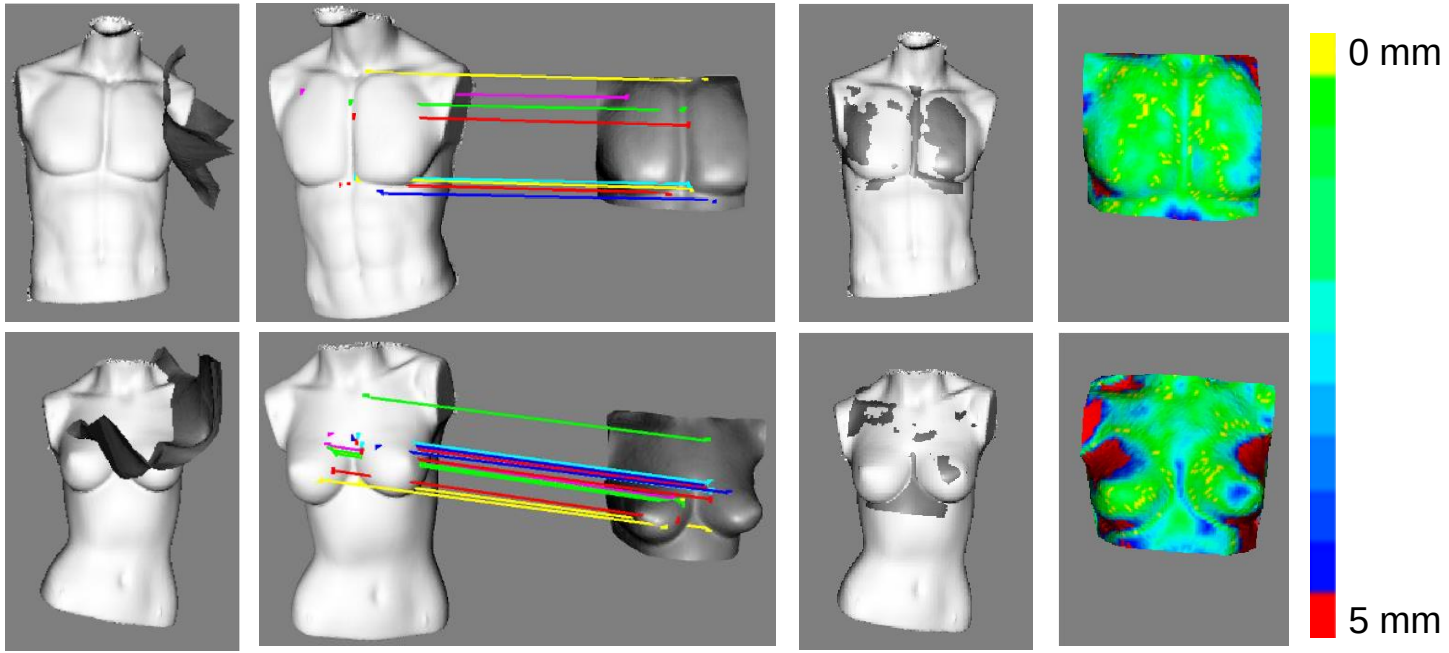


Figure 6: Both rows from left to right: original position, correspondences, registration, refinement (S. Bauer and J. Wasza, Pattern Recognition Lab, FAU)

Stereo Vision in Image-guided Radiation Therapy

Figure 7: Overview of the workflow in image-guided radiation therapy (AlignRT system, VisionRT)

Topics

Applications in Medical Image Processing

Summary

- Take Home Message
- Further Readings

Take Home Message

In conclusion of the units on feature detectors and descriptors we have seen several applications:

- image stitching in microscopic imaging,
- augmented reality in open liver surgery,
- and 3-D range imaging in radiation therapy.

Credits:
We acknowledge the contributions of F.F. Li, E. Angelopoulou, D. Lowe, and A. Berg for their material in units 9-14 (on feature detectors/descriptors).

Further Readings

- A. E. Johnson and M. Hebert. “Using Spin Images for Efficient Object Recognition in Cluttered 3D Scenes”. In: *IEEE Transactions on Pattern Analysis and Machine Intelligence* 21.5 (May 1999), pp. 433–449. DOI: 10.1109/34.765655
- S. Beller et al. “Image-guided Surgery of Liver Metastases by Three-dimensional Ultrasound-based Optoelectronic Navigation”. In: *British Journal of Surgery* 94.7 (Mar. 2007), pp. 866–875. DOI: 10.1002/bjs.5712