

Biomedical Imaging Algorithms group

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Jan Kybic

- 1994–1998 Ing., FEL ČVUT, Prague
- 1998–2001 Ph.D., EPFL, Lausanne, Switzerland
- 2001–2003 post-doc, INRIA, Sophia-Antipolis, France
- 2003–... FEL ČVUT
- 2010–2011 sabbatical, EPFL, Lausanne
- 2011 associate Professor / doc. (habilitation)
- 2011–2013 vice-dean for IT
- 2013–... department head
- 2015 full professor

Biomedical Imaging Algorithms group

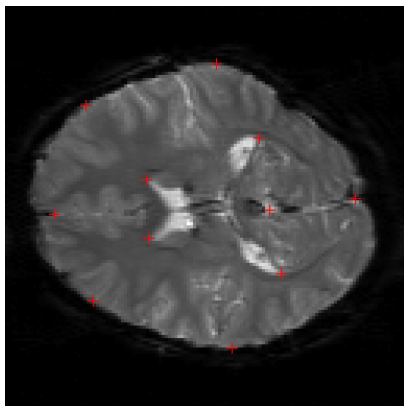
Head: Jan Kybic

- ▶ Postdocs: Jan Hering
- ▶ PhDs: M. Janatka, G. Yu (visiting)
- ▶ Mc./Bc. students: B. Petryshak, D. Tyemnák, B. Doubek, P. Kočíš
- ▶ Former Postdocs: J. Švihlík, F. Martinez, R. Nava, F. Varray, T. Dietenbeck
- ▶ Former PhDs: J. Borovec, M-A. Pinheiro, M. Leibl, J. Podlipská, J. Krátký, M. Uherčík, J. Vandemeulebroucke, J. D. García, J. Petr, M. Barva

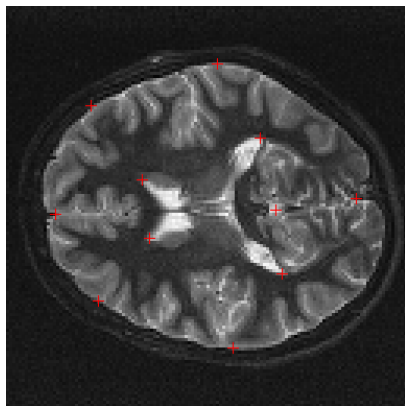
Image registration

(problem definition)

Image registration estimates a displacement field $\mathbf{x}' = T_{\theta}(\mathbf{x})$



$f(\mathbf{x})$



$g(\mathbf{x}')$

RGB/Hyperspectral registration



colposcopy images, cervical cancer detection
use color information, high-dimensional mutual information

J.D. García
(video)

Breathing motion model for radiation therapy (1)

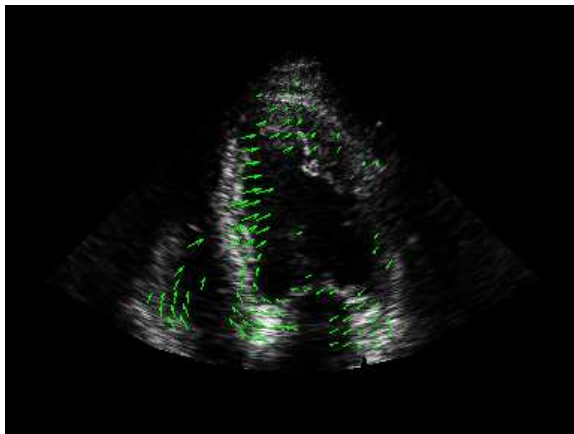
- ▶ Uncertainty during treatment planning and delivery

Jef Vandemeulebroucke, with CREATIS, INSA, Lyon

Breathing motion model for radiation therapy (2)

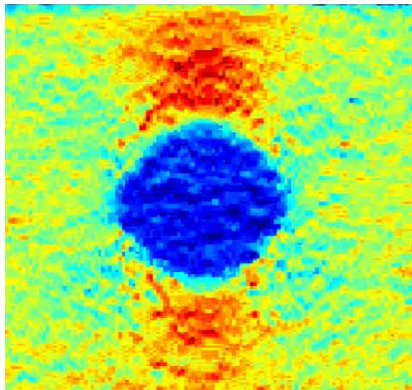
- ▶ Model from 4D CT.
- ▶ Parameter identification from cone-beam CT during irradiation.

Ultrasound



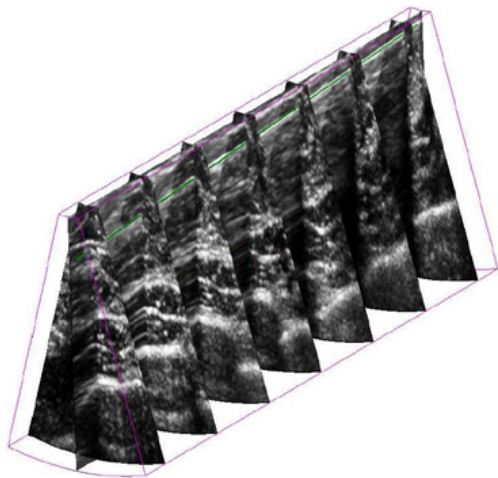
motion estimation

Ultrasound



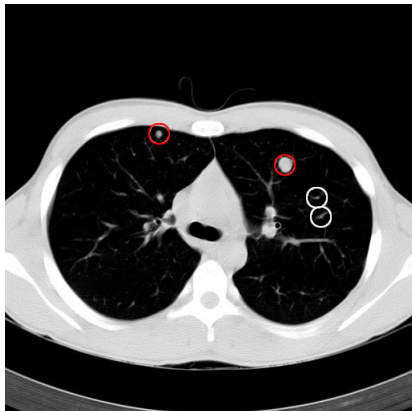
elastography

Ultrasound



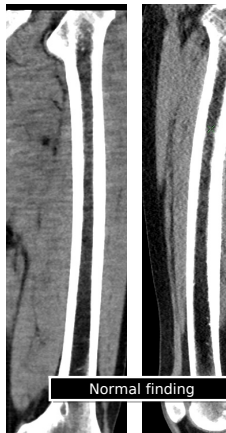
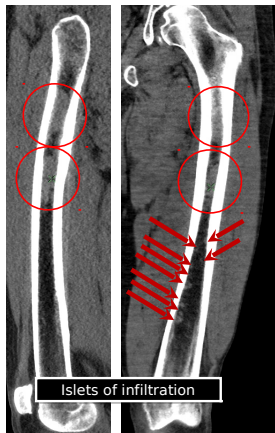
3D ultrasound, tool detection

Lung nodule detection



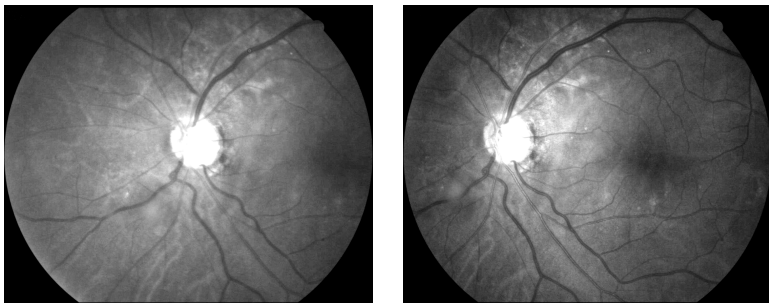
Femur segmentation

Multiple myeloma detection



Geometrical graph matching

Blood vessels, nerve fibers, pulmonary airways. . .

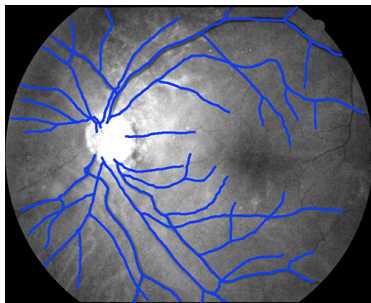
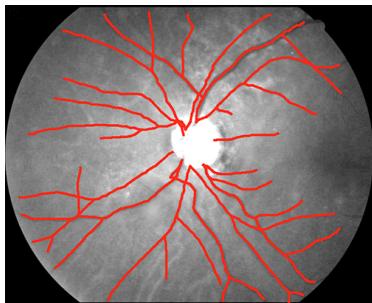


Human retina

Idea: extract graphs, match graphs, interpolate transformation

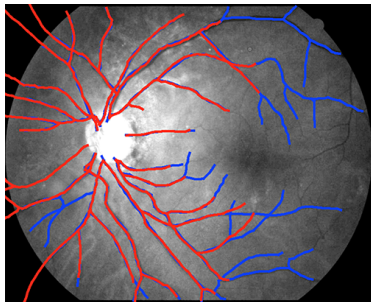
PhD work of Miguel Pinheiro

Geometrical graph matching



Extracted vessels

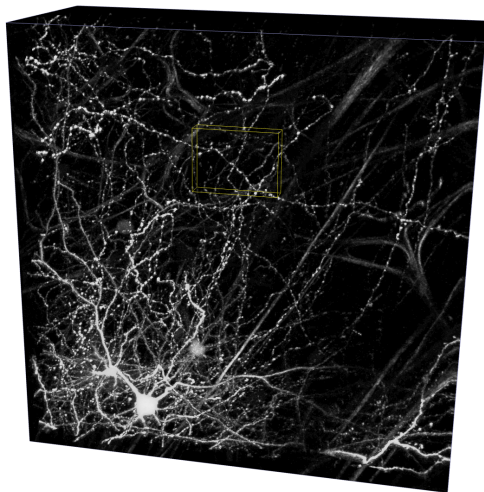
Geometrical graph matching



Registered images

3D microscopy of neuronal fibers

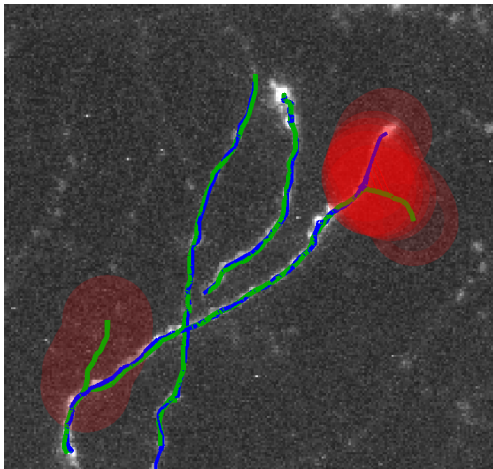
Segmentation, registration, change detection



Two-photon microscopy

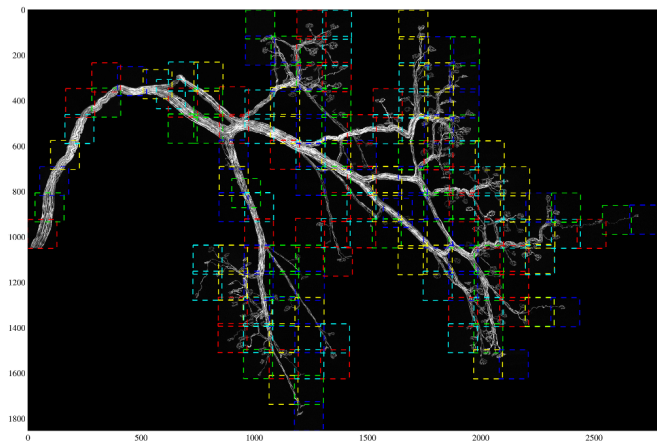
3D microscopy of neuronal fibers

Segmentation, registration, change detection



Change detection

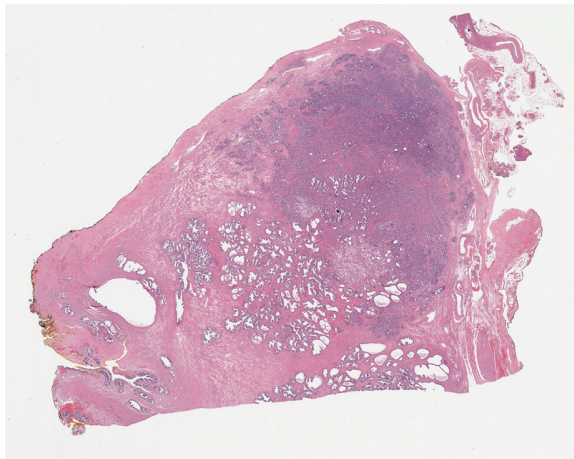
Neuronal fiber tracking



150 3D blocks $1024 \times 1025 \times 160$, 34GB

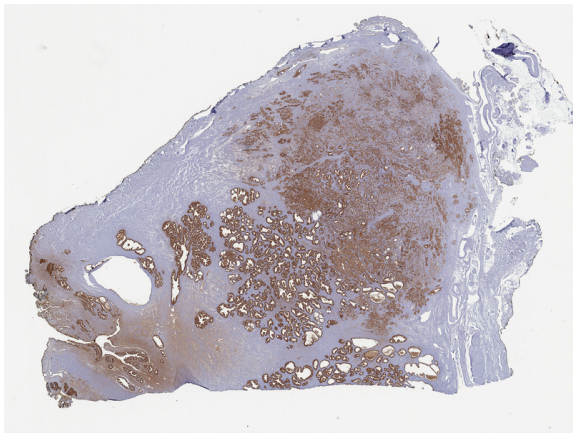
Neuronal fiber tracking

Registration from segmentation



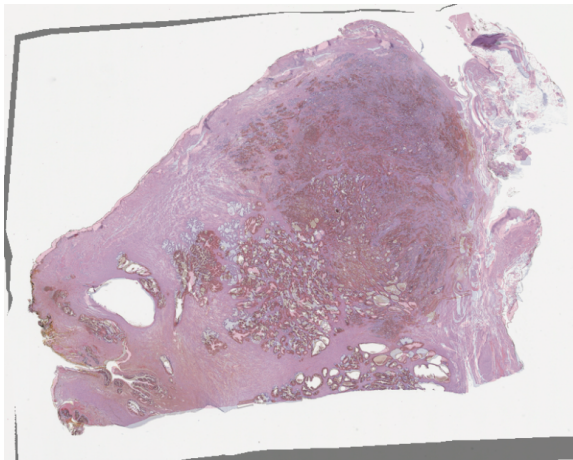
Prostate, hematoxyline and eosine

Registration from segmentation



Prostate, PSAP (anti prostate specific acid phosphatase)

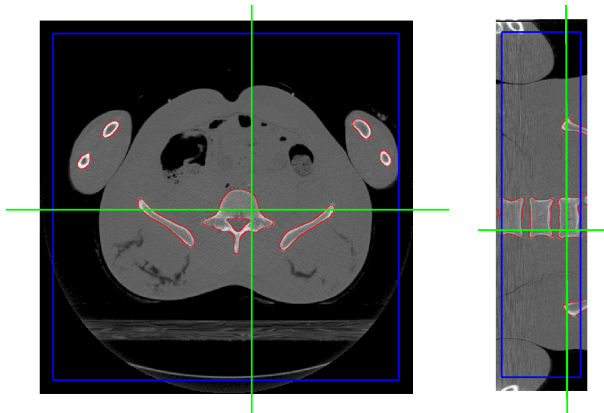
Registration from segmentation



Overlap after.

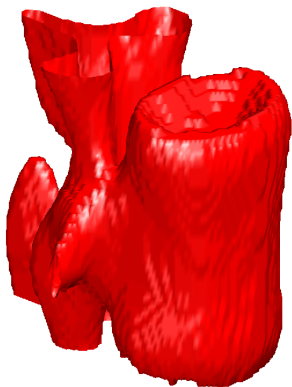
Similar accuracy to alternatives but much faster.

3D segmentation, fast discrete levelsets



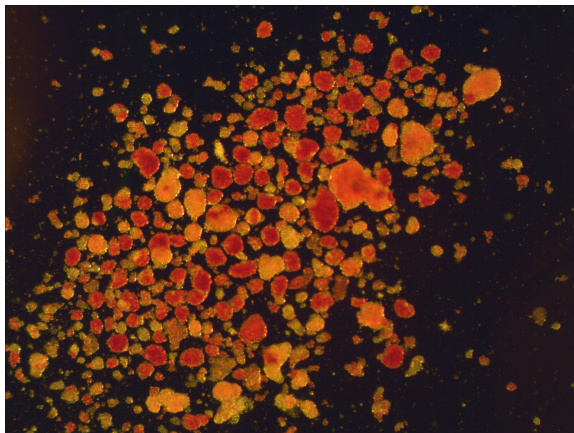
100× speedup
Jakub Krátký

3D segmentation, fast discrete levelsets



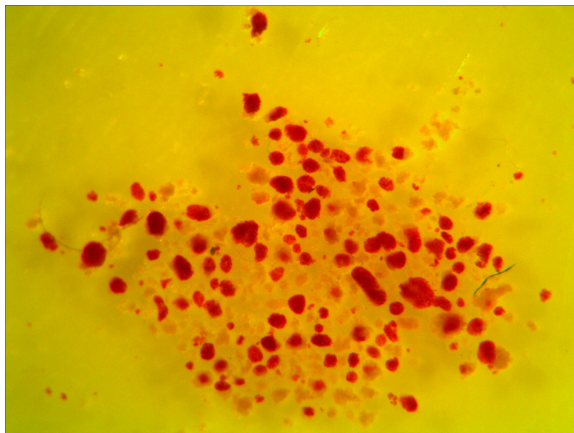
100× speedup
Jakub Krátký

Detection and counting of Langerhans islets



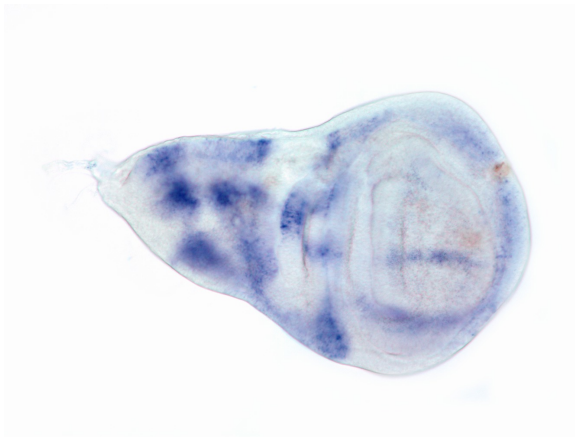
Langerhans islets, dark field microscopy

Detection and counting of Langerhans islets



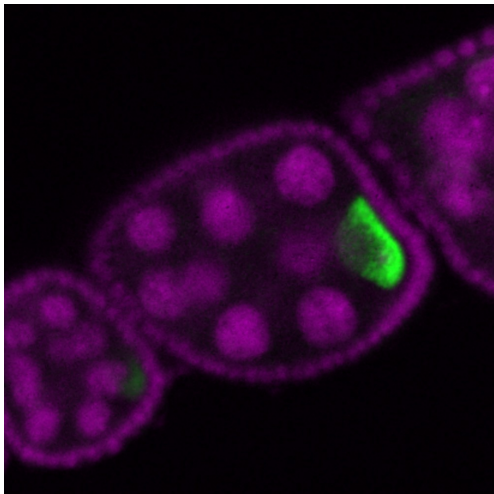
Langerhans islets, bright field microscopy

Gene expression



Drosophila, imaginal disc, wing

Gene expression



Drosophila, oocytes, cut

Current diploma/bachelor projects

- ▶ Analysis of blood microcirculation videos
- ▶ X-ray source spatial density evaluation
- ▶ X-ray source spatial density evaluation
- ▶ Creating 3D meshes
- ▶ Histology microscopy image processing
- ▶ Deep learning for automatic detection of multiple myeloma
- ▶ Tumor (type) detection from histopathological images
- ▶ Segmentation of carotid artery from histology and ultrasound
- ▶ Cartilage segmentation
- ▶ Functional MRI of hypercapnia data
- ▶ ...

<http://cmp.felk.cvut.cz/~kybic/proposed.html>